

**FRONTIER HARD CHROME  
LONG-TERM MONITORING REPORT  
EVENT 23  
VANCOUVER, WASHINGTON**

*Prepared for*

**Washington State Department of Ecology  
PO Box 47600  
Olympia, Washington 98504**

WESTON Work Order No. 15272.001.002.0030

December 2016

*Prepared by*

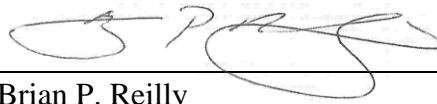
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## 1. INTRODUCTION AND BACKGROUND

### 1.1 INTRODUCTION

This Long-Term Monitoring Report has been prepared by Weston Solutions, Inc. (WESTON) to support Leidos, Inc. (Leidos) and the Washington State Department of Ecology (Ecology) with Long-Term Monitoring of the Frontier Hard Chrome (FHC) site located in Vancouver, Washington. The work was conducted by WESTON under subcontract agreement P010186904 with Leidos, authorized by Ecology under Prime Contract No. C1100139; Delivery Order No. C11139B1.

This report describes the sampling activities performed and analytical results obtained during “Event 23” of the Long-Term Groundwater Monitoring program at FHC. Sampling activities for Event 23 were conducted from September 13 through September 15, 2016. The Event 23 sampling event included a reduced number of sampled wells as compared to the previous Event 22 (October 2014) due to the monitoring wells situated on the subject property having been previously sampled and decommissioned in preparation for the proposed redevelopment of that property.

The FHC site was the subject of a remedial action (RA) conducted in September 2003. The purpose of the RA was to treat the site’s chromium-contaminated soil and groundwater to levels specified in the Record of Decision. Long-term monitoring is required to track off-site plume concentrations as well as show that the remedy is maintaining its operational functionality.

The first three FHC groundwater monitoring events (Events 1 through 3) were conducted for the United States Environmental Protection Agency (EPA). In October 2004, responsibility for the site was turned over to Ecology. As a result of WESTON’s familiarity with this site and the associated property owners, Ecology contracted WESTON to perform the next two rounds of monitoring (Events 4 and 5). Ecology amended WESTON’s contract in February 2006 and again in July 2007 to perform 14 additional rounds of quarterly monitoring, with the last event to be completed in June 2009.

In the summer and fall of 2007, EPA conducted a Long-Term Monitoring Optimization (LTMO) study to assess monitoring requirements at the FHC site. As a result of this study, ten wells were deleted from the monitoring program (EPA, 2008). Ecology amended WESTON’s contract to delete the remaining monitoring events except for Event 14, which was completed in September 2008. Event 15 (September 2009), Event 16 (September 2010), Event 17 (September 2011), Event 18 (October 2012), and Event 19 (April 2013) were each completed by WESTON under annually-issued Authorization/Contracts. Event 20 (December 2013), Event 21 (April 2014), and Event 22 (October 2014) were completed by WESTON under a Prime Contract between Leidos and Ecology.

Between August and October 2012, EPA completed a second five-year review (FYR) of the FHC site to confirm that cleanup levels continue to be met, to ensure that institutional controls remain effective, and to reassess the effectiveness of the long-term monitoring program (EPA, 2013). As a result of the FYR, wells B87-8 and RA-MW-12A were to be sampled semi-annually through at least 2015. Samples collected from these wells were to be analyzed for both total chromium and hexavalent chromium during this period. In addition, field test kits will be utilized at appropriate

locations to measure dissolved oxygen (DO) and ferrous iron ( $\text{Fe}^{2+}$ ) so as to increase the reliability of the geochemical data. Prior to the current event (Event 23), these wells were last sampled during Event 22 (October 2014). Well RA-MW-12A was not sampled by WESTON during the current event (Event 23) due to the monitoring well having been previously sampled and decommissioned by the subject property owner in preparation for the proposed redevelopment of the property.

This report documents the results of sampling for Event 23, which was conducted by WESTON under subcontract agreement P010186904, Modification #03 (August 2016) with Leidos and authorized by Ecology under Prime Contract No. C1100139; Delivery Order No. C11139B1. All Event 23 work was performed in accordance with the project work plan titled *Frontier Hard Chrome, Long-Term Monitoring Plan* (WESTON, 2004).

## 1.2 BACKGROUND AND PROBLEM DEFINITION

### 1.2.1 Site Background

The FHC site is located at 113 “Y” Street in southeastern Vancouver, Washington. The site is located in Section 25, Township 2 North, Range 1 East, of the Willamette Meridian in Clark County, Washington. The geographic coordinates for the site are 45° 37’ 18.8” North latitude and 122° 38’ 43.3” West longitude. A site location map is shown in Figure 1.

The site was historically occupied by several metal fabricating businesses. In addition, the site was historically used for storage and as a staging area for adjacent facilities. As of October 2014, there were no buildings or permanent structures located on site. The entirety of the site, as well as the adjacent parcels to the south and east, were enclosed behind a chain link fence and were being used for equipment/vehicle storage and minor maintenance of plumbing and heating, ventilation, and air-conditioning (HVAC) equipment. The site encompasses approximately 0.5 acre and is bordered to the north by a scrap metal facility, to the east by a campus of the Northwest Renewable Energy Institute, to the south by the property addressed as 2428 East 1<sup>st</sup> St. (formerly occupied by Test-U truck driving school), and to the west by “Y” St. A site layout map is shown in Figure 2.

The FHC site was historically occupied by chrome plating facilities between approximately 1958 and 1983. The property was first developed circa 1958 with the addition of hydraulic dredge fill material and construction rubble. Pioneer Plating operated at the site from approximately 1958 to 1970 and Frontier Hard Chrome operated at the site from approximately 1970 to 1983. Between approximately 1958 and 1976, untreated process wastewater from the facility, which included hexavalent chromium and additional heavy metals, was discharged directly to the City of Vancouver’s sanitary sewer system. Circa 1976, the City of Vancouver and Ecology requested that the facility cease discharging all chromium-contaminated wastewaters to the system. Subsequent to this request, Frontier Hard Chrome began discharging the untreated chromium-contaminated wastewater to an on-site “dry well,” which continued for approximately seven years. In December 1982, the FHC site was proposed for inclusion on the National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA or Superfund). FHC terminated its operations in January 1983.

Work began on the remedial design for the FHC site in October 2001 and was completed in February 2003. The RA; which consisted of building demolition, treatment of source area soil and

groundwater, and installation of an in-situ redox manipulation (ISRM) treatment wall; was completed in September 2003.

### 1.2.2 Problem Definition

The goal of the RA was to treat source area soil and groundwater to reduce hexavalent chromium concentrations such that groundwater down-gradient of the site would attenuate to total chromium concentrations of less than 50 micrograms per liter ( $\mu\text{g/L}$ ). To demonstrate this, groundwater quality was monitored in two areas. The first area consisted of wells located immediately within and down-gradient of the ISRM treatment wall, which were monitored to ensure the continued operational functionality of the ISRM wall. The second area consisted of the historical chromium-contaminated groundwater plume located down-gradient of the ISRM wall. This plume, which did not receive treatment during the RA, was monitored to track the long-term expected reduction in total chromium concentrations as a result of the elimination of the source of hexavalent chromium and the ISRM wall.

Long-term groundwater monitoring is required by the site's Record of Decision. Additional information regarding regulatory actions related to the FHC site is available at the EPA Region 10 Cleanup Sites website: <http://yosemite.epa.gov/R10/cleanup.nsf/sites/cleanuplist>.

## 1.3 MONITORING SCHEDULE

Groundwater sampling and monitoring events were conducted three times by EPA during the first year after completion of the RA; events were completed in February, April, and August 2004.

In September/October 2004, monitoring of the FHC site was turned over to Ecology. Sampling of the site groundwater for Ecology occurred in May and December 2005 under the Original Contract with WESTON. In February 2006, Ecology amended WESTON's contract (Amendment #1) to perform six additional rounds of quarterly monitoring that would occur in March 2006, June 2006, September 2006, December 2006, March 2007, and June 2007.

In July 2007, funding was received from Ecology for an additional eight quarters of groundwater monitoring (Amendment #3). These additional quarterly monitoring events were scheduled for September 2007, December 2007, March 2008, June 2008, September 2008, December 2008, March 2009, and June 2009.

In June 2008, as a result of the recommendations of the LTMO study (EPA 2008), Ecology issued Amendment #4 to WESTON which removed the remaining rounds of sampling from the contract with the exception of a single event to be completed in September 2008. The work conducted in September 2009 (Event 15), September 2010 (Event 16), September 2011 (Event 17), October 2012 (Event 18), and April 2013 (Event 19) was completed under individual Authorization/Contracts. The work conducted in December 2013 (Event 20), April 2014 (Event 21), and October 2014 (Event 22) was completed under a subcontract agreement between WESTON and Leidos and authorized by Ecology under Leidos' Prime Contract.

This report documents the results of the September 2016 (Event 23) sampling event.

## 2. SAMPLING ACTIVITIES AND RESULTS

### 2.1 MONITORING WELL SAMPLING PROCEDURES

Sampling activities for Event 23 were conducted from September 13 through 15, 2016 by WESTON staff in accordance with the *Long-Term Monitoring Plan* (WESTON 2004). The monitoring wells in the vicinity of the FHC site are shown on Figure 2.

The Event 23 sampling event included a reduced number of sampled wells as compared to the previous Event 22 (October 2014) due to the monitoring wells situated on the subject property having been previously sampled and decommissioned in preparation for the proposed redevelopment of that property.

Eleven (11) wells were sampled in September 2016. These wells consisted of the following:

Shallow “A” Zone Wells:	Deep “B” Zone Wells:
B85-4	W85-6B
B87-8	W97-19B
W85-6A	W98-21B
W97-18A	W99-R5B
W97-19A	
W98-21A	
W99-R5A	

Monitoring well construction information and the field data sheets from Event 23 are provided in Appendix E.

Well purging and sampling were performed according to sampling guidelines and WESTON standard operating procedures (SOPs). The wells were sampled with a peristaltic pump equipped with new polyethylene tubing deployed to mid-screen depth at each well. The wells were purged prior to sampling until monitored field parameters [turbidity, conductivity, pH, dissolved oxygen, oxidation-reduction potential (ORP), and temperature] stabilized. The field parameter readings were recorded on field sampling forms.

Based upon the Event 16 (September 2010) analytical results, EPA and Ecology determined that it was no longer necessary to analyze the FHC groundwater samples for the complete list of Priority Pollutant (PP) metals and only chromium analysis was retained for Event 17 (September 2011) and subsequent events. Based on the recommendations of EPA’s second FYR (EPA, 2013), the samples collected from wells RA-MW-12A and B87-8 during Event 19 (April 2013) and subsequent events were to be analyzed for both total chromium and hexavalent chromium. Well RA-MW-12A was not sampled by WESTON during the current event (Event 23) due to the monitoring well having been previously sampled and decommissioned by the subject property owner in preparation for the proposed redevelopment of the property.

All field ground water samples [i.e., not duplicate quality control (QC) samples] were analyzed for total chromium per EPA Method 200.7 inductively-coupled plasma/atomic emission spectrometry (ICP-AES). In cases where groundwater turbidity was greater than 10 nephelometric turbidity units (NTUs), samples were to be passed through a 0.45-micron filter in the field and an additional sample aliquot would be collected and submitted for dissolved chromium analysis; however, none of the sampled collected during Event 23 exhibited a NTU greater than 10. In addition, a sample aliquot was collected and submitted for dissolved chromium analysis from well B87-8 due to the historical presence of black particulates in the water column. Total and dissolved chromium concentrations from the 11 collected field samples are presented in Table 1.

Per the recommendations of EPA's second FYR, between Event 19 (April 2013) and Event 22 (October 2014) all semi-annually monitored wells were analyzed for total and dissolved (field-filtered) hexavalent chromium per EPA Method 7010/7195 graphite furnace atomic absorption (GFAA). This analytical method was selected in order to attain the lower Reporting Limit (RL) of 2 µg/L as compared to the method used during prior events, EPA Method 7196A, which was limited to a 50 µg/L reporting limit. Preceding the current sampling event (Event 23) a properly accredited analytical laboratory could not be identified for hexavalent chromium by GFAA. An alternative EPA Method of 218.6 [determination of dissolved hexavalent chromium in water by ion chromatography (IC)] was selected, approved, and utilized during the event. EPA Method 218.6 requires that all samples are filtered prior to entering the IC column; therefore only dissolved chromium analysis was conducted. Using this IC method, a RL of 0.03 µg/L was attained. Since well RA-MW-12A was not included in this monitoring event, only one field sample, which was collected from well B87-8 and was passed through a 0.45-micron filter in the field, was submitted for hexavalent chromium analysis. The reported concentration from this sample is presented in Table 1.

Selected samples were analyzed for sulfate and dissolved sulfur to provide an assessment of the distribution of byproducts from the reducing agent used during ISRM treatment wall installation. Dissolved sulfur samples were passed through a 0.45-micron filter in the field. These samples were collected from wells: B85-4, B87-8, W85-6A, and W99-R5A. Sulfate and dissolved sulfur concentrations, as well as additional measured field parameters, are presented in Table 2.

## **2.2 ANALYTICAL RESULTS**

### **2.2.1 Chromium**

Total chromium was detected in the groundwater above the laboratory RL of 2.50 µg/L in one (1) of the 11 sampled wells. This water sample did not exhibit a dissolved chromium concentration above the RL of 5.00 µg/L. No additional water samples were submitted for dissolved chromium analysis.

One (1) of the shallow "A" zone wells exhibited a chromium concentrations that was at or above the laboratory RL. This well, B87-8, exhibited a total chromium concentration of 8.82 µg/L; dissolved chromium was not detected at or above the laboratory reporting limit of 5.00 µg/L. The duplicate water sample collected from this well exhibited a total chromium concentration of 12.5 µg/L, resulting in a relative percent difference (RPD) between the samples outside of acceptable criteria; however, since the sample results for total chromium were less than five times the RL,

data qualification is not required. The shallow “A” zone groundwater chromium concentrations are presented in Figure 3. Field-filtered groundwater sample data (i.e., dissolved) were used, when available, in preparing Figure 3.

None of the deeper “B” zone wells exhibited a total chromium concentration that was at or above the laboratory RL. None of the samples collected from the “B” zone wells were submitted for dissolved chromium analysis. The deeper “B” zone groundwater chromium concentrations are presented in Figure 4.

In the sample collected from Well B87-8, dissolved (field-filtered) hexavalent chromium was reported at a concentration of 0.029 µg/L. This result is qualified as ‘estimated’ due to the reported result being less than the laboratory RL of 0.030 µg/L. The duplicate sample collected from this well exhibited a dissolved hexavalent chromium concentration of 0.045 µg/L, which did not require additional qualification. Dissolved hexavalent chromium concentration data is presented in Table 1.

Histograms presenting the chromium concentration trends in groundwater over time are included in Appendix A. Filtered sample data (when available) were used in preparing the histograms. The Event 23 laboratory data sheets for total/dissolved chromium and total/dissolved hexavalent chromium are provided in Appendix B.

### 2.2.2 Water Quality

Dissolved oxygen (DO) concentrations measured during the Event 23 sampling ranged from 0.36 milligrams per liter (mg/L) in well B85-4, which is located approximately 200 feet downgradient of the ISRM treatment wall, to 7.74 mg/L in well W85-6B, which is located approximately 560 feet down-gradient of the ISRM treatment wall. Although, no samples were collected from within the ISRM treatment wall during Event 23, the DO concentration exhibited in well B87-8, which is also located approximately 200 feet downgradient of the ISRM treatment wall, was also relatively low at 0.46 mg/L. These relatively low DO concentrations collected from immediately down-gradient of the ISRM treatment wall indicate that the wall is likely still reductive, which is necessary for treatment of hexavalent chromium.

Per the recommendations of EPA’s second FYR, DO and Fe<sup>2+</sup> concentrations were also determined during Event 23 using field test kits for samples collected from well B87-8. EPA also recommended DO and Fe<sup>2+</sup> concentrations be collected from well RA-MW-12A; however, this well was not sampled during the event so no concentrations were determined. DO measurements were collected by utilizing a Hach Model OX-2P kit (Drop count titration/Modified Winkler method) and following the low range test procedure. Fe<sup>2+</sup> measurements were collected by utilizing a Hach Model IR-18C field kit (Color disc/1,10 phenanthroline method). The sample collected from well B87-8 exhibited a Fe<sup>2+</sup> of ‘less than 0.5 mg/L’ (i.e., lowest range of color disc) and was estimated based upon the color to be approximately 0.25 mg/L. The sample exhibited a DO of ‘no oxygen present’ (i.e., the solution did not turn yellow in Step 9 of the procedure) or less than 0.2 mg/L, which is the detection limit of the field kit.

The groundwater ORP measured during the Event 23 sampling ranged from -103.1 millivolts (mV) in well B87-8 to 88.3 mV in well B85-4.

The groundwater specific conductivity measured during the Event 23 sampling ranged from 0.216 millisiemens per centimeter (mS/cm) in well W97-18A to 0.568 mS/cm in well B85-4.

The groundwater pH measured during the Event 23 sampling ranged from 4.96 in well B85-4 to 7.24 in well W85-6B.

Sulfate concentrations from the four (4) groundwater samples ranged from 12.6 mg/L to 76.2 mg/L and dissolved sulfur concentrations ranged from 3.8 mg/L to 24 mg/L. The maximum sulfur and sulfate concentrations were exhibited in the sample collected from well B85-4, which is located approximately 200 feet downgradient of the ISRM treatment wall. The second largest sulfur and sulfate concentrations (17 mg/L and 53 mg/L, respectively) were exhibited in the sample collected from well B87-8, which is also located approximately 200 feet downgradient of the ISRM treatment wall. The minimum sulfur and sulfate concentrations were exhibited in the sample collected from well W99-R5A, which is located approximately 2,400 feet downgradient of the ISRM wall.

Water quality data from this event is presented in Table 2 and Table 3. The Event 23 laboratory data sheets for sulfate and dissolved sulfur are provided in Appendix B.

### **2.3 GROUNDWATER FLOW DIRECTION AND ELEVATION**

Groundwater surface elevations were determined using the known elevation of the top of each well casing and the depth-to-groundwater measured in each long-term monitoring well. The depth-to-groundwater measurements were collected from 18 wells between approximately 1520 and 1640 hours on September 12, 2016. Groundwater elevations were not measured in well W85-3A since the well could not be located; therefore, data from this well was not used in flow direction and elevation calculations. Groundwater elevation data is presented in Table 4 and Figure 5.

The calculated groundwater elevations in wells W97-19A and W97-19B have been anomalously low during the last several sampling events. The casing elevations for these two wells, in addition to three other wells, were corrected after completion of the RA due to two different datums having been historically used at the site. The remaining three wells were resurveyed in 2007 due to the development of the shopping center. It is suspected that the correction factor, which was an average based on the relative differences from eight wells, is not appropriately applied to these wells. Based upon this information, data from these wells was not used in groundwater flow direction and elevation calculations.

A new concrete pad for roll-off containers was installed at the location of well W98-20A between September 2011 and October 2012. The well monument was preserved during the pad installation; however, the groundwater elevation measurements collected during subsequent events have been anomalously high. It is suspected that the well casing may have been impacted by the construction of the concrete pad and this well was not used in groundwater flow direction and elevation calculations.

During the December 2013 sampling event (Event 20), the top of the PVC casing of well W85-6A was inadvertently removed while attempting to release the frozen well cap. Subsequent groundwater elevation measurements have appeared anomalous high and it is suspected that the

top of casing elevation may have been slightly raised. Based on this information, this well was not used in groundwater flow direction and elevation calculations.

The Columbia River elevation at the United State Geological Survey (USGS) gauging station 14144700, which is located approximately 1.3 miles west of the FHC site at the northern end of the I-5 Bridge, was obtained for use in assessing groundwater flow characteristics since the alluvial aquifer beneath the FHC site is hydraulically connected to the river. Between 1515 and 1645 hours on September 12, 2016, the elevation of the river ranged from 4.35 to 4.58 feet above mean sea level (AMSL) (corrected to NGVD 1929 by adding 1.82 feet to the measured gage height). The daily mean elevation for September 12, 2016 was 3.40 feet AMSL; which is 1.08 feet lower than the daily mean elevation during the previous October 2014 fall sampling event (Event 22). The river elevation information can be obtained from:

<http://waterdata.usgs.gov/usa/nwis/uv?14144700>.

The groundwater flow direction and gradient at the FHC site were calculated based on the depth-to-groundwater measurements collected on September 12, 2016. The measured groundwater surface elevations ranged from 3.62 feet AMSL in well W97-19B to 3.93 feet AMSL in well W98-20A; which is, on average, 1.10 feet lower in elevation than during the previous October 2014 fall sampling event (Event 22). Utilizing the depth information collected from wells B85-3, W97-18A, W85-7A, W98-21A, and W99-R5A; the groundwater in the vicinity of the site flows in a southerly direction with a horizontal gradient of approximately 0.00013 feet per foot (ft/ft) as presented in Figure 5. If additional wells are included in the calculations, the flow directions become more diverse; ranging from approximately west to south-southeast. It is suspected that these variations are caused by a combination of: anomalies in the measured groundwater depths and/or top of casings elevations; variations between A-zone and B-zone groundwater flows; the relatively flat gradient at the site; and actual shifts in the flow directions due to variations in hydrogeologic conditions. Due to groundwater levels in the aquifer being controlled primarily by the nearby Columbia River, the groundwater flow direction is expected to have substantial variations across the field area throughout the year; groundwater has been documented to flow away from the river during high stage events (EPA, 2013).

## 2.4 QUALITY ASSURANCE

Data quality was verified by collecting field duplicate samples. The analytical laboratory quality assurance program (e.g., laboratory duplicates and matrix spike analyses) is discussed in Section 3 and Appendix D. The quality control results are presented in Table 5.

Field duplicates were collected from three of the sampled wells including: W85-6A (QA-1), W97-19A (QA-2), and B87-8 (QA-3). The duplicate sample collected from B87-8 was analyzed for total chromium (unfiltered), dissolved chromium (field-filtered), and dissolved hexavalent chromium (field-filtered). The duplicate sample collected from W97-19A was analyzed for total chromium (unfiltered). The duplicate sample collected from W85-6A was analyzed for sulfate.

The duplicate sample, QA-1, collected from well W85-6A, had perfect correlation with the field sample for sulfate (0.0% RPD).



The duplicate sample, QA-2, collected from well W97-19A, could not be correlated to the field sample for total chromium since neither the duplicate nor the field sample exhibited concentrations of this analyte above the laboratory RL.

The duplicate sample, QA-3, collected from well B87-8, had relatively poor correlation with the field sample for total chromium (34.5% RPD). This correlation is outside of the acceptance criteria specified in the Quality Assurance Project Plan (QAPP). However, since the sample results were less than five times the RL, data qualification is not required. For dissolved chromium, the duplicate sample could not be correlated to the field sample since neither the duplicate nor the field sample exhibited concentrations of this analyte above the laboratory RL. For dissolved hexavalent chromium, the duplicate sample had relatively poor correlation with the field sample (43.2% RPD); however, since the field sample result was below the RL and is already qualified as an estimated value, no additional qualification is required. The relatively high RPD between the duplicate and field samples for total (unfiltered) chromium from this well is likely due to variations in the amount of insoluble chromium-containing particulates suspended in the water column, which has historically been observed as black particulates.

## 2.5 INVESTIGATION-DERIVED WASTES

Investigation-derived waste (IDW) generated during the sampling event consisted of well purge/decontamination water, used personal protective equipment (PPE), and disposable sampling supplies. During sampling, purge/decontamination water was securely stored on site in 5-gallon buckets. Subsequent to the conclusion of sampling, approximately 30 gallons of purge/decontamination water was transported to the City of Vancouver's operations center and disposed of in accordance with the Special Wastewater Discharge Authorization Number 2016.08, which was issued to WESTON by the City of Vancouver on August 29, 2016 and is valid through September 12, 2019. PPE and other solid IDW were disposed to general refuse.

## 2.6 DISCUSSION AND CONCLUSIONS

Detectable concentrations of total recoverable chromium were identified in one (1) of the 11 wells sampled during the current Event 23. This well, B87-8, is screened within the shallower "A" groundwater zone and is located approximately 200 feet downgradient of the in-situ redox manipulation (ISRM) treatment wall. The field sample collected from this well exhibited a total chromium concentration of 8.82 micrograms per liter ( $\mu\text{g/L}$ ). The well exhibited a 'non-detectable' (i.e., less than 5  $\mu\text{g/L}$ ) concentration of dissolved (field-filtered) chromium. During the sampling of well B87-8, black particulates were observed within the extracted purge water. These suspended particulates are thought to contain insoluble chromium and are likely responsible for the relatively large discrepancy in total chromium concentrations [i.e., relative percent difference (RPD) of 34.5%] exhibited between the field water sample and the quality control (i.e. duplicate) sample collected from this well. However, since the reported concentration in the field sample was less than five times the reporting limit (RL), no qualification of the result was required.

During the current Event 23, Well W97-19A, which is located approximately 0.25 mile southwest of the ISRM wall, did not exhibit a total chromium concentration above the laboratory detection limit of 2.5  $\mu\text{g/L}$ . This is notable due to the well having previously exhibited an anomalously high

concentration of total chromium concentration (i.e., 10.4 µg/L) during the 2014 fall sampling event (Event 22).

The water sample collected from well B87-8 was additionally analyzed for dissolved (field-filtered) hexavalent chromium. This sample exhibited a dissolved hexavalent chromium concentration of 0.029; however, this result is qualified as 'estimated' due to the reported result being less than the laboratory RL of 0.030 µg/L.

No wells were sampled from within the ISRM Treatment Wall during the current Event 23; however, dissolved oxygen (DO) data collected from the two sampled wells located immediately (i.e., approximately 200 feet) downgradient of the ISRM treatment wall indicates that an area of reducing conditions likely still exists and that, therefore, the hexavalent chromium treatment zone is likely still active. The DO concentrations at these wells ranged from 0.36 mg/L in well B85-4 to 0.46 mg/L in well B87-8.

Sulfur and Sulfate concentrations in the applicable wells sampled during the current Event 23; which included wells B85-4, B87-8, W85-6A, and W99-R5A; were similar to the previous 2014 fall sampling event (Event 22) with the exception of well B87-8, which exhibited concentrations approximately 100 percent higher (i.e., double) than during the previous event.

Groundwater elevations collected during the current Event 23 were, on average, approximately 1.10 feet lower than during the previous 2014 fall sampling event (Event 22). The daily mean stage level of the Columbia River reported during the current event was reported as being approximately 1.08 feet lower than the daily mean reported during Event 22.

### 3. ANALYTICAL METHODS AND DATA VALIDATION

#### 3.1 ANALYTICAL METHODS REQUIREMENTS AND DATA VALIDATION

The laboratory data quality assurance review and validation of analytical results for 14 water samples has been completed (11 field samples and 3 field duplicate samples). Samples were collected between September 13 and September 15, 2016 from monitoring wells at the Frontier Hard Chrome site. Eleven field samples and two duplicate samples were analyzed for total recoverable chromium; one field sample and one duplicate sample were analyzed for dissolved chromium; one field sample and one duplicate sample were analyzed for dissolved hexavalent chromium; four field samples were analyzed for dissolved sulfur; and four field samples and one duplicate sample were analyzed for sulfate.

The sample obtained from one well, B87-8, was collected both as total recoverable and dissolved fractions, with one fraction submitted for total recoverable chromium analysis and the other filtered at the time of collection and submitted for dissolved chromium and dissolved hexavalent chromium analysis. Additional sample fractions were collected from well B87-8 as field duplicates and submitted for total recoverable chromium analysis, dissolved chromium, and dissolved hexavalent chromium analysis. Additionally, a field duplicate sample fraction was collected from well W97-19A and submitted for total recoverable chromium analyses and a field duplicate sample fraction was collected from well W85-6A and submitted for sulfate analysis. Field duplicate sample fractions were not collected for dissolved sulfur analysis.

Acceptance criteria specified in the QAPP (RPD less than or equal to 20%) were met for all duplicate analyses with the exception of total chromium and dissolved hexavalent chromium results for duplicate samples B87-8 and QA-3. The RPD for total chromium between field sample 1609048-13 (collected from B87-8) and its associated duplicate sample, 1609048-14 (QA-3), was calculated as 34.5%. However, since the sample results for total chromium were less than 5 times the RL, no data qualification is required.

The RPD for dissolved hexavalent chromium between field sample 1609048-13 (collected from B87-8) and its associated duplicate sample, 1609048-14 (QA-3), was calculated as 43.2%. However, the sample result for field sample 1609048-13 was below the RL and is an estimated value. There is no additional qualification required for dissolved hexavalent chromium sample results.

The matrix spike duplicate recovery for sulfur in sample 1609048-06 (collected from B85-4), was 125%, which is outside the control limit of 80-120%. Based upon Laboratory Control Sample Matrix Spike results, which had % recoveries within control limits, and as the matrix spike duplicate % recovery was not significantly outside of control limits, the diluted sample result did not require additional qualification.

The quality assurance review was performed on the laboratory data sheets and the Ecology memorandum to ensure that the analytical results met data quality objectives for the project. All laboratory quality assurance results as applicable (e.g., holding times, blank sample analysis, matrix spike/duplicate analysis, laboratory control sample analysis) supplied to WESTON for the

analyses met acceptance criteria specified in the work plan (WESTON 2004), minus the aforementioned exceptions. Data validation documentation is provided in Appendix D.

#### **4. REFERENCES**

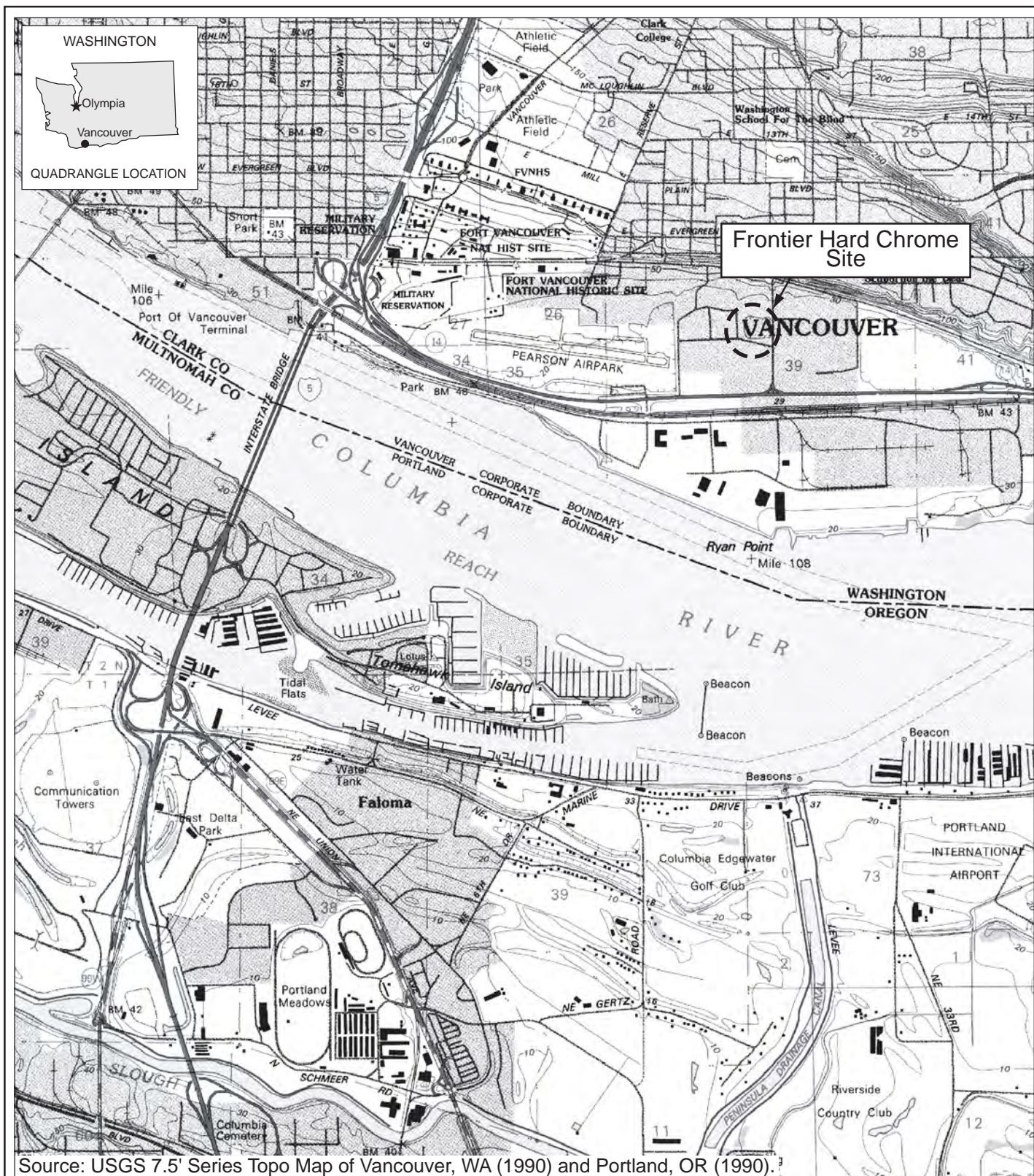
EPA (United States Environmental Protection Agency), 2008. Five Year Review Report for Frontier Hard Chrome Superfund Site. January, 2008.

EPA (United States Environmental Protection Agency), 2013. Second Five Year Review Report for Frontier Hard Chrome Superfund Site. January, 2013.

WESTON (Weston Solutions, Inc.), 2004. Frontier Hard Chrome Long-Term Monitoring Plan. Prepared for the United States Environmental Protection Agency, Region 10, Seattle, Washington. February. 2004.

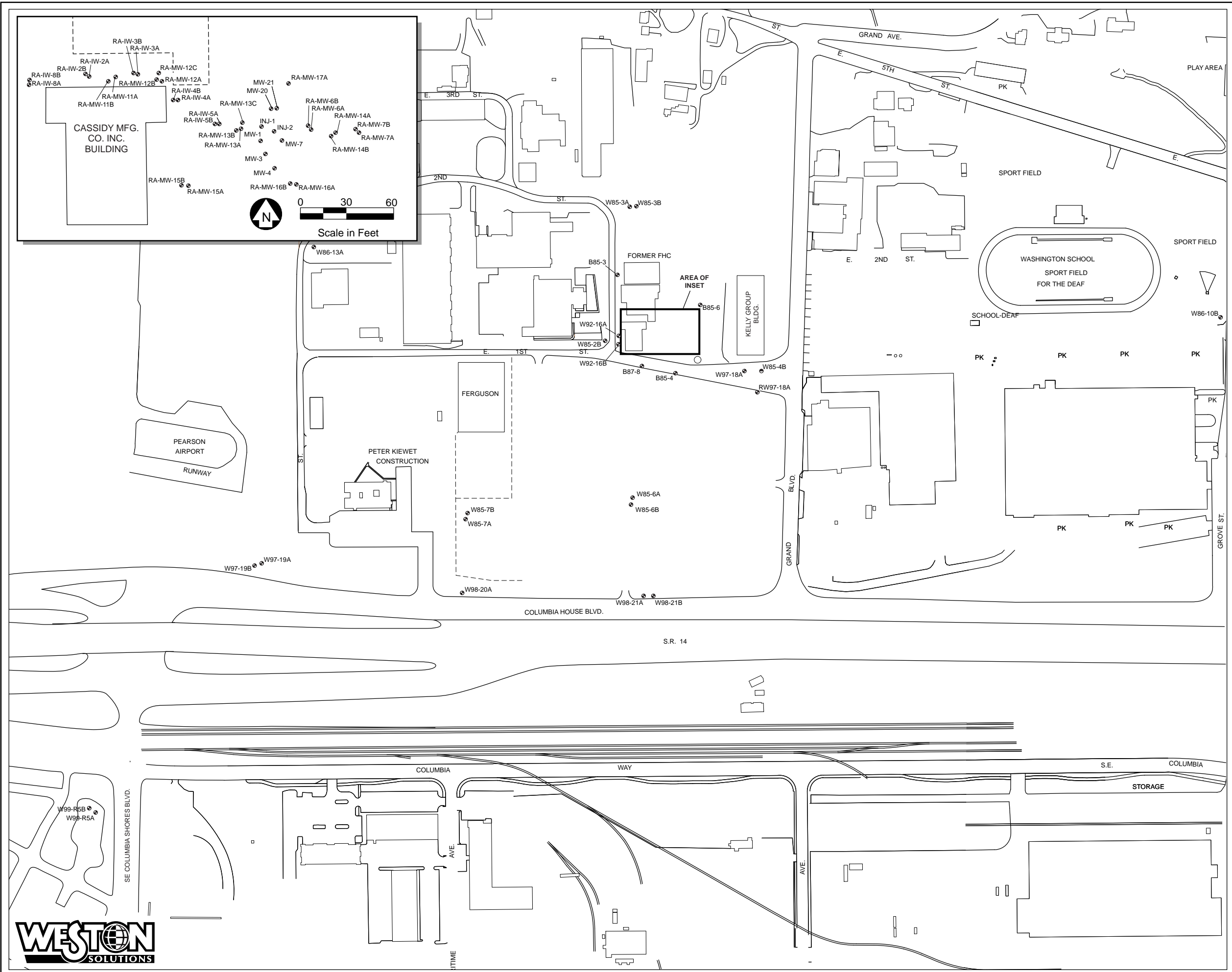
## **FIGURES**





# Frontier Hard Chrome Vancouver, Washington Vicinity Map





**LEGEND**

- W85-5B Monitoring Well Location and ID
- W85-4B Abandoned Well Location and ID
- Fence

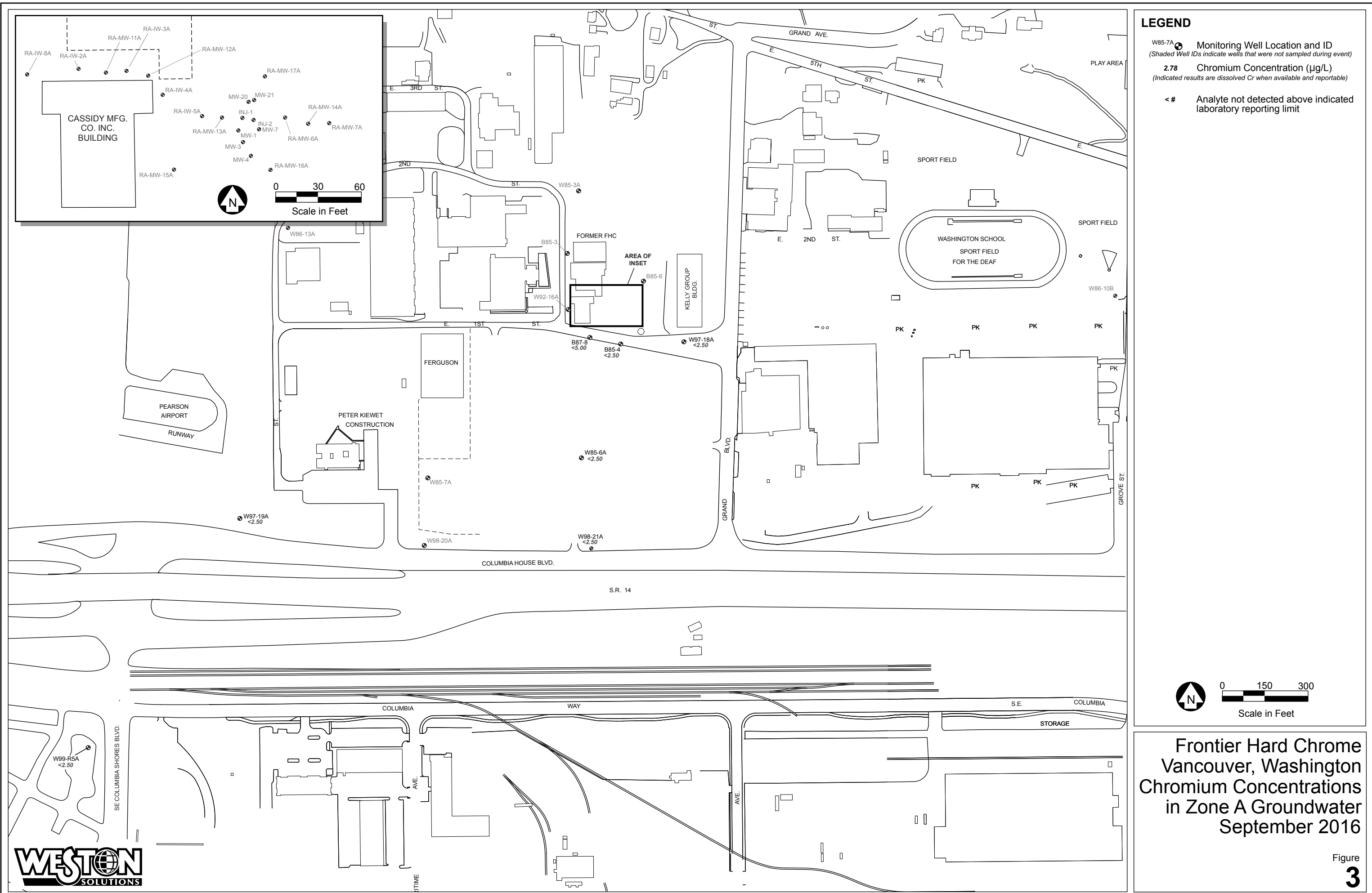
0 150 300  
Scale in Feet

**Frontier Hard Chrome  
Vancouver, Washington  
Monitoring Well Locations**

Figure  
**2**











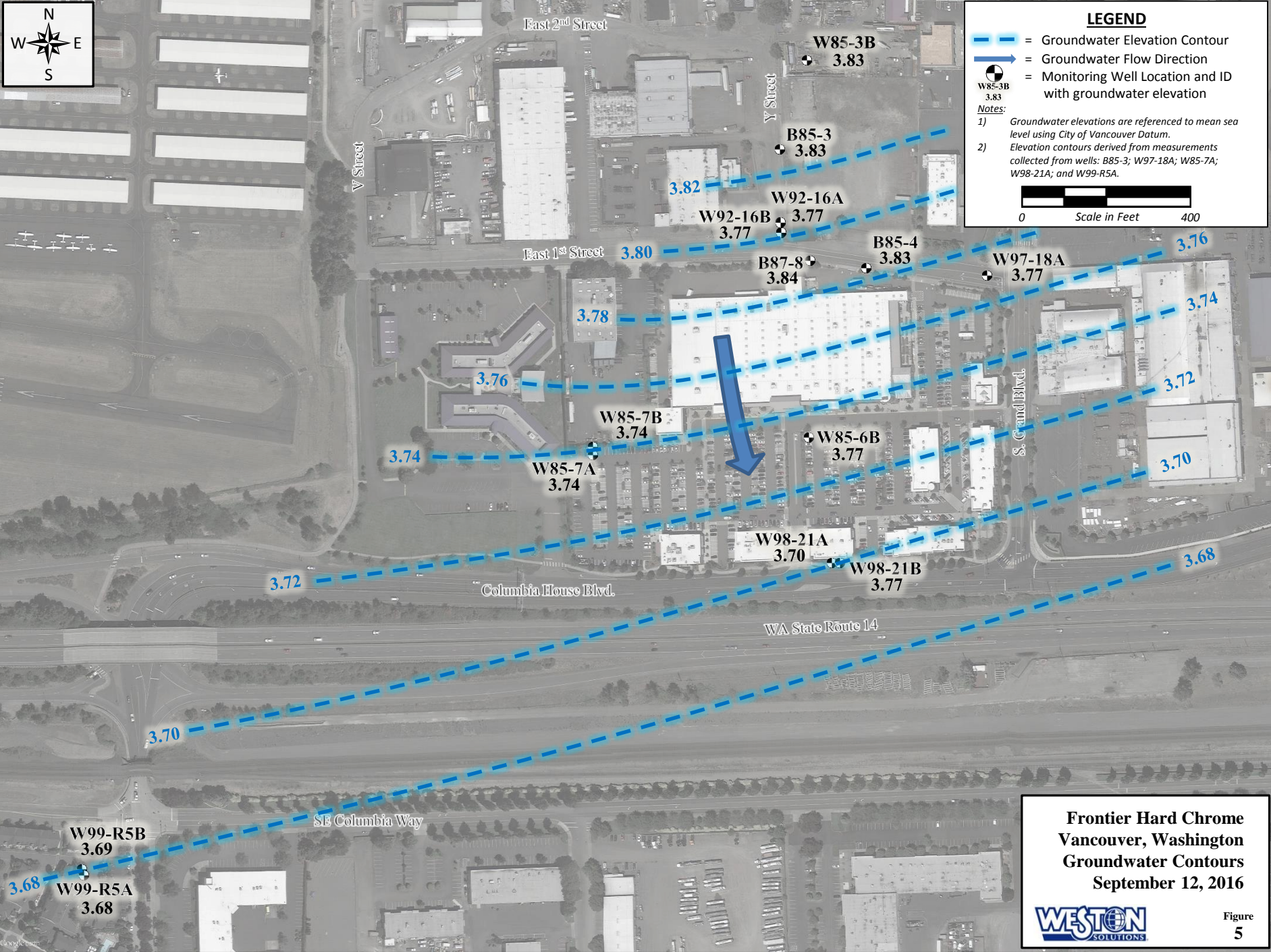


# LEGEND

- = Groundwater Elevation Contour
- = Groundwater Flow Direction
- = Monitoring Well Location and ID with groundwater elevation

## Notes:

- Groundwater elevations are referenced to mean sea level using City of Vancouver Datum.
- Elevation contours derived from measurements collected from wells: B85-3; W97-18A; W85-7A; W98-21A; and W99-R5A.



Frontier Hard Chrome  
Vancouver, Washington  
Groundwater Contours  
September 12, 2016



## **TABLES**

**Table 1: Frontier Hard Chrome - Event 23 Chromium and Hexavalent Chromium Results**

Well Number <sup>1</sup>	Chromium Concentration (µg/L)		Hexavalent Chromium Concentration (µg/L)		Sample Observations
	Total	Dissolved	Total	Dissolved	
B85-3	—	—	—	—	Not Sampled
B85-4	< 2.50	—	—	—	Clear; no odor; no sheen
B87-8	<b>8.82</b>	< 5.00	—	<b>0.029 J</b>	Slightly cloudy; no odor; no sheen; black particles
RA-MW-12A	—	—	—	—	Not Sampled
RA-MW-12B	—	—	—	—	Not Sampled
RA-MW-12C	—	—	—	—	Not Sampled
RA-MW-15A	—	—	—	—	Not Sampled
RA-MW-15B	—	—	—	—	Not Sampled
RA-MW-16A	—	—	—	—	Not Sampled
RA-MW-16B	—	—	—	—	Not Sampled
RA-MW-17A	—	—	—	—	Not Sampled
W85-6A	< 2.50	—	—	—	Clear; no odor; no sheen
W85-6B	< 2.50	—	—	—	Clear; no odor; no sheen
W92-16A	—	—	—	—	Not Sampled
W92-16B	—	—	—	—	Not Sampled
W97-18A	< 2.50	—	—	—	Clear; no odor; no sheen
W97-19A	< 2.50	—	—	—	Clear; no odor; no sheen
W97-19B	< 2.50	—	—	—	Slightly yellow; no odor; no sheen
W98-21A	< 2.50	—	—	—	Clear; no odor; no sheen
W98-21B	< 2.50	—	—	—	Clear; no odor; no sheen
W99-R5A	< 2.50	—	—	—	Clear; no odor; no sheen
W99-R5B	< 2.50	—	—	—	Clear; no odor; no sheen

- = Not Analyzed/Not Sampled  
 < # = analyte not detected above indicated laboratory reporting limit  
 µg/L = micrograms per liter  
 J = qualified as estimated  
 1 = Only the wells that were sampled during Event 23 and the previous 2014 Event 22 are included.

**Table 2: Frontier Hard Chrome - Event 23 Monitoring Field Parameters<sup>1</sup>**

Well Number <sup>2</sup>	Temp (°C)	Specific Cond. (mS/cm)	DO <sup>3</sup> (mg/L)	pH	ORP (mV)	Dissolved Sulfur (mg/L)	Sulfate (mg/L)	Turbidity (NTU)
B85-3	—	—	—	—	—	—	—	—
B85-4	16.4	0.568	0.36	4.96	88.3	24.0	76.2	1.22
B87-8	15.4	0.374	0.46	6.74	-103.1	17.0	53.3	2.75
RA-MW-12A	—	—	—	—	—	—	—	—
RA-MW-12B	—	—	—	—	—	—	—	—
RA-MW-12C	—	—	—	—	—	—	—	—
RA-MW-15A	—	—	—	—	—	—	—	—
RA-MW-15B	—	—	—	—	—	—	—	—
RA-MW-16A	—	—	—	—	—	—	—	—
RA-MW-16B	—	—	—	—	—	—	—	—
RA-MW-17A	—	—	—	—	—	—	—	—
W85-6A	15.9	0.324	1.22	5.93	-57.3	4.30	13.9	0.98
W85-6B	16.5	0.301	7.74	7.24	-45.6	—	—	0.98
W92-16A	—	—	—	—	—	—	—	—
W92-16B	—	—	—	—	—	—	—	—
W97-18A	16.0	0.216	0.47	5.96	-80.6	—	—	1.05
W97-19A	16.3	0.303	2.80	5.62	-21.5	—	—	2.14
W97-19B	15.0	0.242	0.80	6.17	-46.3	—	—	3.85
W98-21A	15.0	0.314	1.66	6.36	-51.0	—	—	0.72
W98-21B	14.5	0.273	5.22	6.44	-47.6	—	—	0.76
W99-R5A <sup>4</sup>	—	—	—	—	—	3.80	12.6	—
W99-R5B <sup>4</sup>	—	—	—	—	—	—	—	—

- = Not Analyzed / Not Sampled  
 mg/L = milligrams per liter  
 mV = millivolts  
 NTU = nephelometric turbidity unit  
 mS/cm = milliSiemens per centimeter  
 1 = Parameters recorded after measurements stabilized  
 2 = Only the wells that were sampled during Event 23 and the previous 2014 Event 22 are included.  
 3 = Negative DO measurements, which may occur due to instrument sensitivity or calibration errors, are reported as zero value  
 4 = Parameters not recorded as the Well could not be purged due to increased depth to groundwater that exceeded capability of pump

Table 3: Comparison of Conventional Parameters

Well Number	Temperature (°C)																						
	Feb-04	Apr-04	Aug-04	May-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07	Jun-07	Sep-07	Dec-07	Sep-08	Sep-09	Sep-10	Sep-11	Oct-12	Apr-13	Dec-13	Apr-14	Oct-14	Sep-16
B85-3	14.6	14.8	15.2	15.8	14.4	14.1	13.6	14.6	12.4	12.5	13.6	13.7	13.1	8.0	14.0	13.2	14.0	12.5	—	11.7	—	6.63	—
B85-4	14.1	14.4	15.1	14.4	13.9	13.5	14.3	14.5	13.8	14.6	14.4	—	13.5	8.7	14.7	17.0	14.9	13.2	—	12.7	—	7.74	16.4
B87-8	14.5	14.7	15.8	15.2	14.7	14.4	14.5	14.4	13.8	14.4	14.3	14.5	13.6	8.8	14.3	13.7	14.6	13.3	8.4	12.9	12.0	7.60	15.4
RA-MW-12A	14.9	15.9	17.9	15.2	14.9	14.6	14.3	14.9	13.9	14.0	13.9	14.4	13.8	8.7	15.5	13.5	14.5	14.1	9.0	12.7	12.0	7.52	—
RA-MW-12B	14.4	16.6	16.7	15.6	14.3	14.9	14.4	14.5	13.4	14.3	14.1	14.4	13.3	8.5	14.2	13.7	14.0	13.5	—	12.3	—	7.26	—
RA-MW-12C	14.4	16.5	16.6	15.1	14.2	14.3	14.2	14.2	13.1	13.3	14.1	14.1	13.2	8.5	14.4	13.2	14.5	13.2	—	12.6	—	7.40	—
RA-MW-15A	14.3	14.5	15.0	15.0	14.7	14.8	14.7	15.1	14.7	15.3	15.1	14.7	13.6	9.0	14.6	14.1	14.3	13.1	—	13.0	—	7.46	—
RA-MW-15B	13.9	14.4	15.4	14.7	14.1	14.0	14.5	17.2	14.1	14.8	14.9	14.3	13.4	8.8	14.6	14.0	14.3	13.2	—	12.9	—	7.48	—
RA-MW-16A	14.3	14.9	16.0	14.9	15.1	13.3	13.4	14.8	13.8	14.0	13.9	14.1	—	8.6	14.2	13.8	14.2	13.3	—	13.3	—	7.31	—
RA-MW-16B	14.3	14.6	16.0	14.7	13.9	13.7	13.8	15.2	13.4	14.3	13.8	14.1	—	8.8	14.4	14.0	14.1	13.4	—	13.0	—	7.64	—
RA-MW-17A	14.3	15.3	16.7	15.1	14.5	13.7	—	13.9	13.4	13.1	14.1	13.8	13.4	8.5	13.7	13.8	13.8	13.0	—	13.1	—	7.24	—
W85-6A	14.1	14.1	15.5	14.0	—	—	13.7	15.3	13.9	13.2	13.6	14.1	13.2	8.7	15.7	14.4	15.2	14.3	—	14.8	—	8.27	15.9
W85-6B	13.6	13.8	16.3	13.7	—	—	13.8	15.1	13.1	13.1	13.8	15.0	12.9	8.6	16.6	14.5	15.0	14.2	—	12.6	—	8.15	16.5
W92-16A	14.2	15.6	16.1	15.3	14.0	13.8	14.1	15.5	13.6	13.3	14.5	14.5	13.3	8.6	14.8	14.3	15.1	13.9	—	12.9	—	7.38	—
W92-16B	14.1	14.7	16.2	15.2	13.7	13.7	13.8	15.4	13.1	13.3	14.4	14.6	13.0	8.7	14.6	14.0	15.0	13.4	—	11.7	—	7.37	—
W97-18A	11.3	11.0	15.0	12.7	13.9	12.0	—	13.8	13.0	11.6	12.5	13.2	13.0	7.8	13.7	13.6	14.5	13.8	—	13.7	—	8.16	16.0
W97-19A	12.5	13.3	16.0	14.3	13.8	12.9	—	15.3	13.9	13.8	14.1	14.3	13.3	8.7	14.9	14.3	14.9	14.1	—	13.1	—	7.86	16.3
W97-19B	12.7	13.3	15.9	15.3	13.3	12.4	—	15.2	13.0	14.2	14.4	14.5	12.9	8.8	14.1	14.2	15.0	14.0	—	12.4	—	7.48	15.0
W98-21A	13.1	14.3	14.2	13.8	13.9	13.8	13.7	15.0	13.7	13.7	14.0	14.5	12.3	8.4	17.1	14.1	14.5	14.1	—	14.1	—	8.09	15.0
W98-21B	13.1	13.6	14.0	13.8	13.7	13.0	13.7	14.7	13.4	13.5	14.2	14.5	13.2	8.5	16.7	13.8	14.7	13.7	—	13.5	—	7.88	14.5
W99-R5A	14.2	14.9	15.7	14.8	14.8	14.7	15.1	—	13.9	13.9	15.5	15.4	14.1	10.0	14.7	14.3	14.8	14.1	—	12.7	—	7.89	—
W99-R5B	13.9	14.4	15.6	14.4	14.5	13.9	14.7	—	13.5	13.5	15.0	15.2	13.6	9.5	15.1	14.2	14.4	13.9	—	13.2	—	7.95	—
RA-MW-11A	15.7	16.5	17.4	15.7	15.0	15.1	15.1	14.9	13.7	13.8	14.0	14.0	13.5	—	—	—	—	—	—	—	—	—	—
RA-MW-11B	14.9	16.3	17.0	15.6	14.9	14.7	14.7	14.7	13.4	13.6	14.1	14.3	13.2	—	—	—	—	—	—	—	—	—	—
RA-MW-13A	15.0	14.6	15.7	14.9	14.5	14.3	13.7	14.1	12.8	13.8	14.3	14.3	13.2	—	—	—	—	—	—	—	—	—	—
RA-MW-13B	14.8	14.7	15.4	14.9	14.2	14.3	14.1	14.2	13.0	13.9	14.2	13.8	13.2	—	—	—	—	—	—	—	—	—	—
RA-MW-13C	14.2	15.0	14.9	14.5	14.3	13.8	13.8	14.1	12.4	13.9	14.0	14.0	12.9	—	—	—	—	—	—	—	—	—	—
RA-MW-14A	13.9	14.3	15.3	14.6	14.7	10.8	—	13.6	12.7	10.8	13.0	13.2	12.9	—	—	—	—	—	—	—	—	—	—
RA-MW-14B	14.0	14.9	15.5	14.5	14.1	12.3	—	14.0	12.8	11.3	13.8	13.5	12.9	—	—	—	—	—	—	—	—	—	—
W85-7A	11.4	12.6	14.9	13.9	14.5	12.3	13.7	15.9	13.4	12.7	13.4	—	14.5	—	—	—	—	—	—	—	—	—	—
W85-7B	12.1	13.0	14.5	13.6	14.1	12.8	13.4	14.4	13.0	13.0	13.4	—	13.4	—	—	—	—	—	—	—	—	—	—
W97-18B	11.4	12.4	14.4	13.5	13.0	10.7	—	13.8	12.6	12.0	13.6	—	—	—	—	—	—	—	—	—	—	—	—
W98-20A	13.8	12.5	15.4	14.3	14.3	13.1	—	15.3	14.0	13.1	13.6	—	13.2	—	—	—	—	—	—	—	—	—	—

(Table 3 continued)

Well Number	Specific Conductivity (mS/cm)																						
	Feb-04	Apr-04	Aug-04	May-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07	Jun-07	Sep-07	Dec-07	Sep-08	Sep-09	Sep-10	Sep-11	Oct-12	Apr-13	Dec-13	Apr-14	Oct-14	Sep-16
B85-3	0.99	0.90	0.98	0.81	0.54	0.74	0.64	0.72	0.97	0.84	0.68	0.77	0.90	0.81	0.77	0.72	0.65	0.88	—	0.88	—	1.02	—
B85-4	0.41	1.17	0.51	0.71	0.28	0.74	0.33	0.56	0.92	739.00	0.60	—	0.43	0.63	0.58	0.55	0.34	0.42	—	0.52	—	0.57	0.57
B87-8	0.26	0.55	0.36	0.29	0.24	0.38	0.27	0.36	0.44	0.39	0.19	0.33	0.36	0.27	0.32	0.45	0.31	0.39	0.29	0.22	0.22	0.28	0.37
RA-MW-12A	6.01	5.40	4.00	3.32	2.52	2.47	2.37	2.26	2.95	0.85	1.11	1.98	2.34	2.55	2.92	2.59	2.55	2.27	2.32	1.93	2.10	2.07	—
RA-MW-12B	2.25	1.19	1.52	2.56	2.47	1.34	1.39	1.19	2.12	1.12	0.89	1.55	1.49	1.55	1.74	1.11	0.78	0.86	—	0.81	—	0.92	—
RA-MW-12C	2.18	1.34	1.13	0.68	1.09	0.69	0.88	0.53	1.05	0.65	0.49	0.58	0.81	0.80	0.97	0.72	0.54	0.56	—	0.61	—	0.86	—
RA-MW-15A	1.88	1.04	1.08	1.30	1.42	1.53	1.44	1.27	1.74	1.10	1.06	1.06	1.28	1.03	1.04	0.99	0.89	1.11	—	1.16	—	1.19	—
RA-MW-15B	0.47	0.86	0.68	0.64	0.91	0.92	0.80	0.46	1.60	1.16	0.49	0.81	1.22	0.93	0.85	0.49	0.33	0.39	—	0.66	—	0.67	—
RA-MW-16A	2.95	1.46	2.00	1.70	1.07	1.04	1.01	0.80	1.13	1.02	0.83	0.91	—	0.93	1.04	0.89	0.83	0.92	—	0.76	—	0.89	—
RA-MW-16B	2.42	1.19	1.40	1.81	0.92	0.67	0.51	0.43	1.34	1.05	0.32	0.48	—	0.74	0.66	0.49	0.50	0.78	—	0.71	—	0.89	—
RA-MW-17A	1.80	1.80	1.80	1.39	1.18	1.30	—	1.18	1.30	1.04	1.03	1.16	1.47	1.46	1.43	1.23	0.96	1.05	—	0.95	—	1.09	—
W85-6A	0.11	0.33	0.34	299.00	—	—	0.23	0.24	0.24	0.36	0.27	0.32	0.30	0.27	0.24	0.26	0.22	0.25	—	0.25	—	0.33	0.32
W85-6B	0.31	0.41	0.33	0.26	—	—	0.10	0.11	0.17	0.24	0.19	0.20	0.26	0.32	0.22	0.19	0.18	0.22	—	0.21	—	0.30	0.30
W92-16A	0.33	0.25	0.27	0.23	0.24	0.28	0.28	0.37	0.47	0.57	0.47	0.53	0.64	0.61	0.48	0.36	0.36	0.34	—	0.26	—	0.31	—
W92-16B	1.17	1.37	0.95	0.66	0.09	0.34	0.42	0.32	0.61	0.57	0.25	0.44	0.60	0.50	0.15	0.21	0.27	0.27	—	0.09	—	0.20	—
W97-18A	0.11	0.09	0.11	0.08	0.10	0.19	—	0.15	0.16	0.16	0.10	0.14	0.18	0.23	0.21	0.19	0.16	0.17	—	0.18	—	0.30	0.22
W97-19A	0.25	0.26	0.28	0.23	0.23	0.19	—	0.21	0.26	0.24	0.19	0.22	0.26	0.30	0.30	0.26	0.24	0.25	—	0.24	—	0.32	0.30
W97-19B	0.26	0.26	0.29	0.22	0.06	0.19	—	0.20	0.28	0.23	0.19	0.21	0.25	0.30	0.09	0.26	0.24	0.26	—	0.20	—	0.24	0.24
W98-21A	0.16	0.23	0.29	0.45	0.19	0.19	0.22	0.25	0.29	0.29	0.27	0.27	0.09	0.29	0.30	0.28	0.22	0.25	—	0.25	—	0.32	0.31
W98-21B	0.24	0.27	0.27	0.25	0.18	0.22	0.21	0.24	0.32	0.31	0.21	0.26	0.27	0.29	0.26	0.30	0.20	0.27	—	0.23	—	0.21	0.27
W99-R5A	0.24	0.25	0.24	0.22	0.21	0.20	0.20	—	0.27	0.22	0.21	0.21	0.20	0.27	0.28	0.26	0.22	0.25	—	0.24	—	0.31	—
W99-R5B	0.26	0.26	0.27	0.23	0.22	0.22	0.22	—	0.28	0.24	0.21	0.22	0.26	0.29	0.27	0.25	0.23	0.25	—	0.24	—	0.31	—
RA-MW-11A	1.67	1.89	2.02	1.48	1.82	2.01	1.46	1.70	2.21	1.75	1.22	1.62	1.99	—	—	—	—	—	—	—	—	—	—
RA-MW-11B	1.49	2.08	2.02	1.72	2.25	1.17	0.94	1.10	1.50	1.21	0.77	1.05	1.59	—	—	—	—	—	—	—	—	—	—
RA-MW-13A	5.21	2.42	3.29	2.83	2.49	2.17	1.66	1.13	2.33	1.34	1.23	1.47	1.69	—	—	—	—	—	—	—	—	—	—
RA-MW-13B	3.73	1.38	2.15	2.41	2.16	0.81	0.82	0.50	2.22	1.23	0.50	0.98	1.34	—	—	—	—	—	—	—	—	—	—
RA-MW-13C	3.07	1.82	1.41	1.28	0.71	0.79	0.82	0.57	1.36	0.93	0.51	0.60	0.93	—	—	—	—	—	—	—	—	—	—
RA-MW-14A	1.43	1.71	1.96	1.08	0.88	0.87	—	0.92	0.77	0.87	0.74	0.89	0.95	—	—	—	—	—	—	—	—	—	—
RA-MW-14B	1.56	1.21	0.98	1.08	1.00	0.78	—	0.69	0.89	0.87	0.68	0.85	1.02	—	—	—	—	—	—	—	—	—	—
W85-7A	0.13	0.14	0.21	0.12	0.11	0.10	0.16	0.16	0.13	219.00	0.11	—	0.27	—	—	—	—	—	—	—	—	—	—
W85-7B	0.28	0.31	0.32	0.01	0.01	0.01	0.02	0.01	0.03	0.01	0.02	—	0.02	—	—	—	—	—	—	—	—	—	—
W97-18B	0.26	0.24	0.27	0.22	0.19	0.19	—	0.19	0.28	0.23	0.17	—	-	—	—	—	—	—	—	—	—	—	—
W98-20A	0.16	0.15	0.23	0.12	0.12	0.13	—	0.18	0.25	0.18	0.16	—	0.26	—	—	—	—	—	—	—	—	—	—



(Table 3 continued)

Well Number	Dissolved Oxygen (mg/L)																						
	Feb-04	Apr-04	Aug-04	May-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07	Jun-07	Sep-07	Dec-07	Sep-08	Sep-09	Sep-10	Sep-11	Oct-12	Apr-13	Dec-13	Apr-14	Oct-14	Sep-16
B85-3	1.11	0.16	1.57	4.50	0.12	2.97	0.22	1.04	0.80	0.02	0.24	0.15	0.21	0.18	0.39	0.27	0.62	0.28	—	0.42	—	0.21	—
B85-4	0.65	1.37	1.50	0.33	0.20	0.22	0.52	1.61	0.30	0.03	0.27	—	0.24	0.26	0.40	0.34	0.55	0.38	—	0.34	—	0.66	0.36
B87-8	0.13	1.03	1.06	0.35	0.28	0.53	0.37	0.52	0.25	0.01	7.00	0.19	0.11	0.24	0.40	0.17	0.62	0.42	0.29	0.21	0.19	0.66	0.46
RA-MW-12A	0.24	0.09	0.20	0.13	0.04	0.00	52.70	17.00	56.41	0.00	0.00	0.00	0.00	0.00	0.51	1.96	1.28	2.88	0.00	1.58	0.00	0.18	—
RA-MW-12B	0.27	0.07	0.27	0.07	0.05	1.26	45.10	12.16	73.22	0.00	9.82	0.00	0.00	0.00	0.40	0.23	0.27	0.20	—	0.71	—	0.65	—
RA-MW-12C	0.20	0.14	0.42	0.25	0.07	1.10	5.16	4.93	3.33	0.01	0.40	0.23	0.00	0.28	0.53	0.20	0.18	0.49	—	0.97	—	0.43	—
RA-MW-15A	0.33	0.21	1.53	0.47	0.15	8.34	0.47	2.89	0.29	0.04	0.19	0.48	0.10	0.32	0.48	0.32	0.56	0.42	—	2.59	—	0.19	—
RA-MW-15B	0.22	0.10	0.74	0.44	0.18	0.79	0.30	1.25	0.30	0.06	0.15	0.18	0.12	0.30	0.60	0.26	0.54	0.19	—	1.66	—	0.26	—
RA-MW-16A	0.73	0.27	1.39	1.60	0.11	5.40	0.54	0.49	0.31	0.05	0.36	0.31	—	0.15	0.43	0.31	0.65	0.43	—	2.65	—	0.53	—
RA-MW-16B	0.75	0.15	0.86	0.75	0.33	1.85	0.27	0.27	0.21	0.05	0.24	0.16	—	0.19	0.33	0.25	0.36	0.17	—	1.77	—	0.85	—
RA-MW-17A	0.60	0.19	1.99	0.60	0.20	3.69	—	0.74	0.35	0.11	0.14	0.22	0.10	0.19	0.51	0.32	0.45	0.37	—	2.33	—	0.54	—
W85-6A	4.92	0.43	0.85	4.90	—	—	1.86	2.06	2.63	0.09	0.51	0.93	2.52	2.08	4.01	2.97	3.51	5.07	—	1.95	—	2.30	1.22
W85-6B	3.46	6.13	6.54	5.50	—	—	7.87	3.83	5.15	0.05	4.96	5.95	6.10	4.87	13.98	10.48	9.20	10.86	—	8.75	—	9.17	7.74
W92-16A	0.98	0.13	2.49	3.10	0.28	0.15	0.45	0.32	0.33	0.13	0.32	0.22	0.11	0.15	0.54	0.28	0.48	0.24	—	1.51	—	0.28	—
W92-16B	0.14	0.53	1.97	3.40	5.40	1.02	0.54	2.12	0.23	0.80	4.16	1.60	0.11	1.31	14.02	10.90	8.21	9.27	—	8.30	—	6.48	—
W97-18A	1.27	0.74	1.09	0.50	1.10	4.00	—	1.45	0.90	0.90	0.67	0.69	0.69	0.64	0.33	0.19	0.66	1.00	—	0.30	—	0.26	0.47
W97-19A	4.72	1.79	22.73	4.60	0.97	3.51	—	3.50	9.37	1.00	3.74	3.57	4.69	3.92	6.56	2.42	3.67	2.85	—	5.31	—	3.96	2.80
W97-19B	1.81	1.31	2.60	2.60	1.10	2.99	—	3.43	4.13	0.52	2.83	3.55	3.44	3.01	9.81	1.67	4.06	2.80	—	0.16	—	0.44	0.80
W98-21A	1.29	1.49	3.03	13.30	1.20	1.05	3.26	2.59	4.97	0.07	0.80	2.44	2.53	2.58	3.18	2.81	3.52	4.53	—	2.65	—	3.14	1.66
W98-21B	1.24	3.29	2.82	17.70	3.90	1.08	3.37	2.42	4.90	0.02	3.52	1.98	2.73	2.58	8.21	2.60	7.13	4.92	—	4.70	—	5.46	5.22
W99-R5A	4.72	4.26	5.60	5.30	3.30	1.83	5.10	—	6.26	4.90	4.53	4.55	5.38	5.40	6.33	5.10	5.13	4.38	—	5.80	—	5.68	—
W99-R5B	3.97	2.71	4.70	5.10	1.90	2.03	4.20	—	4.90	3.40	3.49	3.86	4.66	4.34	5.76	5.03	4.55	4.86	—	4.79	—	4.23	—
RA-MW-11A	0.32	0.10	0.66	6.69	0.16	0.00	24.20	22.50	1.80	0.00	0.13	0.00	0.00	—	—	—	—	—	—	—	—	—	—
RA-MW-11B	0.19	0.15	0.50	0.14	0.10	0.19	26.60	4.44	2.50	0.00	0.81	0.15	0.00	—	—	—	—	—	—	—	—	—	—
RA-MW-13A	1.63	0.17	1.13	0.53	0.11	0.38	0.27	1.00	0.00	0.04	0.24	0.20	0.11	—	—	—	—	—	—	—	—	—	—
RA-MW-13B	0.73	0.16	0.73	0.51	0.21	0.45	0.35	0.49	0.00	0.09	0.14	0.51	0.09	—	—	—	—	—	—	—	—	—	—
RA-MW-13C	0.22	0.15	0.43	1.40	2.98	0.96	0.41	0.80	0.00	0.06	0.46	0.26	0.07	—	—	—	—	—	—	—	—	—	—
RA-MW-14A	0.89	0.22	5.96	0.51	0.22	6.74	—	0.88	1.75	0.60	0.21	0.17	0.11	—	—	—	—	—	—	—	—	—	—
RA-MW-14B	1.08	0.10	2.77	0.42	0.12	2.58	—	0.52	1.73	0.90	0.13	0.20	0.10	—	—	—	—	—	—	—	—	—	—
W85-7A	4.05	3.17	2.18	4.30	2.20	6.70	5.89	3.09	2.39	0.18	3.29	—	2.60	—	—	—	—	—	—	—	—	—	—
W85-7B	2.78	5.11	6.10	8.70	4.00	10.30	10.96	3.77	0.06	0.10	8.79	—	7.85	—	—	—	—	—	—	—	—	—	—
W97-18B	2.01	5.56	4.52	4.90	2.00	1.17	—	4.25	4.59	1.09	4.72	—	—	—	—	—	—	—	—	—	—	—	—
W98-20A	4.92	3.76	5.50	5.00	3.20	5.10	—	3.63	9.14	5.70	3.03	—	4.87	—	—	—	—	—	—	—	—	—	—

(Table 3 continued)

Well Number	pH																						
	Feb-04	Apr-04	Aug-04	May-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07	Jun-07	Sep-07	Dec-07	Sep-08	Sep-09	Sep-10	Sep-11	Oct-12	Apr-13	Dec-13	Apr-14	Oct-14	Sep-16
B85-3	6.49	6.68	6.91	6.39	6.70	6.64	6.42	6.33	6.73	6.68	6.66	6.88	7.02	6.88	6.74	6.85	5.82	6.82	—	6.92	—	6.79	—
B85-4	6.14	6.26	6.53	6.22	6.51	6.49	6.21	6.28	6.47	6.53	6.53	—	7.21	6.62	6.28	6.41	5.20	6.77	—	6.73	—	6.61	4.96
B87-8	6.55	6.31	6.73	6.54	6.68	6.57	6.35	6.61	6.71	6.71	6.89	6.99	7.44	6.90	6.90	6.63	6.14	6.79	7.18	6.91	7.00	6.79	6.74
RA-MW-12A	8.86	8.73	8.86	8.98	8.41	8.19	8.46	8.54	7.59	7.86	7.97	7.97	8.53	7.16	7.64	7.79	6.58	7.50	7.72	7.47	7.41	7.66	—
RA-MW-12B	7.77	7.83	7.92	8.30	8.68	8.16	7.76	7.83	8.06	7.94	7.55	7.79	8.28	7.75	7.25	7.31	6.43	7.40	—	7.41	—	7.63	—
RA-MW-12C	8.13	7.92	8.09	7.95	8.14	7.89	7.92	7.90	7.74	7.80	7.79	8.14	8.57	7.99	7.81	7.70	6.68	7.78	—	7.89	—	7.79	—
RA-MW-15A	6.35	6.37	6.74	6.20	6.30	6.47	6.28	6.09	6.53	6.61	6.50	6.68	7.19	6.63	6.53	6.51	5.80	6.53	—	6.55	—	6.52	—
RA-MW-15B	6.35	6.83	7.18	6.39	6.39	6.51	6.26	6.61	6.39	6.48	6.84	6.73	7.18	6.66	6.52	7.01	6.33	7.23	—	6.73	—	6.79	—
RA-MW-16A	6.61	6.61	6.75	6.42	6.44	6.62	6.44	5.96	6.68	6.71	6.64	6.82	—	6.74	6.62	6.56	4.35	6.54	—	6.57	—	6.45	—
RA-MW-16B	6.42	7.12	7.09	6.31	7.12	7.06	6.85	6.09	6.62	6.78	7.27	7.41	—	7.11	7.18	7.28	5.43	6.83	—	6.83	—	6.74	—
RA-MW-17A	6.55	6.43	6.61	6.20	6.39	6.50	—	6.42	6.66	6.59	6.47	6.69	7.26	6.65	6.68	6.55	5.57	6.52	—	6.61	—	6.56	—
W85-6A	6.23	6.22	6.40	6.36	—	—	6.25	5.47	6.63	6.47	6.50	6.77	6.85	6.71	6.24	6.52	6.07	6.54	—	6.65	—	6.46	5.93
W85-6B	6.40	6.42	6.68	6.62	—	—	8.93	7.16	8.05	6.83	6.76	7.15	7.09	6.87	8.50	9.12	7.80	7.65	—	8.63	—	7.41	7.24
W92-16A	6.42	6.42	6.72	6.60	6.56	6.60	6.67	5.87	6.59	6.52	6.44	6.75	7.41	6.61	6.40	6.56	5.47	6.60	—	6.81	—	6.65	—
W92-16B	7.51	7.58	7.63	7.59	6.88	7.54	7.38	6.35	7.46	7.62	7.51	7.70	8.23	7.21	7.22	7.17	5.93	6.93	—	6.61	—	6.72	—
W97-18A	5.83	5.96	6.19	6.17	6.78	6.57	—	5.08	6.29	6.32	6.23	6.54	7.07	6.33	6.33	6.30	5.20	6.25	—	6.46	—	6.31	5.96
W97-19A	6.35	6.24	6.28	6.35	6.59	6.41	—	5.53	6.55	6.58	6.57	6.91	7.33	6.51	6.35	6.53	3.30	6.55	—	6.77	—	6.19	5.62
W97-19B	6.68	6.49	6.30	6.47	6.68	6.68	—	5.89	6.83	6.76	6.72	6.95	7.50	6.65	7.14	6.78	4.94	6.70	—	6.86	—	6.81	6.17
W98-21A	5.92	6.07	6.68	6.18	6.30	6.25	6.11	4.80	6.16	6.43	6.34	6.53	6.81	6.48	6.07	6.25	5.62	6.34	—	6.45	—	6.28	6.36
W98-21B	6.04	6.07	6.90	6.24	6.64	6.36	6.07	5.55	6.38	6.39	6.46	6.48	7.08	6.44	6.19	6.38	5.34	6.49	—	6.54	—	6.31	6.44
W99-R5A	6.03	5.98	6.28	6.21	6.22	6.28	6.23	—	6.40	6.30	6.18	6.58	6.73	6.31	6.52	6.35	5.60	6.40	—	6.38	—	6.16	—
W99-R5B	6.20	6.23	6.55	6.33	6.63	6.55	6.26	—	6.62	6.63	6.54	6.90	6.92	6.54	6.66	6.67	5.95	6.64	—	6.73	—	6.51	—
RA-MW-11A	7.51	7.53	7.00	6.52	6.64	6.64	6.46	6.48	6.43	6.69	6.68	6.86	7.26	—	—	—	—	—	—	—	—	—	—
RA-MW-11B	7.66	7.90	7.20	6.70	6.73	7.00	6.69	6.85	6.86	7.01	6.94	7.17	7.61	—	—	—	—	—	—	—	—	—	—
RA-MW-13A	7.15	7.15	7.03	6.70	6.86	6.82	6.82	6.96	7.02	7.08	6.95	7.11	7.21	—	—	—	—	—	—	—	—	—	—
RA-MW-13B	7.23	7.56	7.30	6.86	6.99	7.15	6.95	7.52	7.04	7.06	7.43	7.35	7.27	—	—	—	—	—	—	—	—	—	—
RA-MW-13C	7.36	7.35	7.44	7.33	7.48	7.25	7.25	7.45	7.45	7.44	7.53	7.81	7.62	—	—	—	—	—	—	—	—	—	—
RA-MW-14A	6.64	6.81	6.99	6.50	6.60	6.60	—	5.98	6.76	6.65	6.62	6.89	6.85	—	—	—	—	—	—	—	—	—	—
RA-MW-14B	6.90	7.14	7.33	6.75	6.78	6.87	—	6.40	6.98	6.82	6.89	7.06	7.04	—	—	—	—	—	—	—	—	—	—
W85-7A	6.24	6.04	6.26	6.20	6.30	6.35	6.24	5.69	6.45	6.33	6.40	—	6.61	—	—	—	—	—	—	—	—	—	—
W85-7B	6.63	6.51	6.71	5.91	6.18	6.14	6.37	5.39	6.57	6.23	6.30	—	6.71	—	—	—	—	—	—	—	—	—	—
W97-18B	6.57	6.35	6.67	6.41	6.60	6.16	—	6.25	6.55	6.61	6.68	—	—	—	—	—	—	—	—	—	—	—	—
W98-20A	6.01	5.91	6.32	5.97	6.29	6.18	—	4.90	6.26	6.41	6.19	—	7.02	—	—	—	—	—	—	—	—	—	—

(Table 3 continued)

Well Number	ORP (mV)																						
	Feb-04	Apr-04	Aug-04	May-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07	Jun-07	Sep-07	Dec-07	Sep-08	Sep-09	Sep-10	Sep-11	Oct-12	Apr-13	Dec-13	Apr-14	Oct-14	Sep-16
B85-3	-7	-107	-37	-47	-93	-62	-43	-53	-59	-43	-66	-30	-52	-39	27	-61	-50	-58	—	-48	—	-61	—
B85-4	10	41	59	218	-26	75	86	179	161	182	90	—	123	108	162	220	479	119	—	19	—	96	88
B87-8	-8	31	17	199	2	73	86	160	167	170	87	95	106	96	107	12	42	-17	-10	14	-42	-2	-103
RA-MW-12A	-468	-466	-430	-417	-403	-393	-363	-311	-373	-324	-374	-369	-396	-310	-154	-304	-333	-278	-307	-295	-340	-320	—
RA-MW-12B	-363	-321	-315	-415	-414	-345	-327	-355	-374	-313	-363	-361	-379	-318	-215	-283	-308	-214	—	-264	—	-231	—
RA-MW-12C	-282	-179	-154	-239	-314	-234	-191	-164	-217	-137	-129	-235	-289	-219	-167	-233	-275	-178	—	-253	—	-294	—
RA-MW-15A	-47	4	39	10	-12	-137	-28	-52	-24	13	-58	41	7	47	93	50	68	3	—	-41	—	49	—
RA-MW-15B	-5	28	15	17	-11	16	34	76	32	48	-15	64	29	82	122	75	407	67	—	-37	—	82	—
RA-MW-16A	-94	-45	-58	-156	-103	-160	-93	-125	-125	-112	-109	-21	—	-30	120	96	315	67	—	-30	—	16	—
RA-MW-16B	-57	-70	-60	-85	-130	-131	-66	-155	-113	-88	-112	-43	—	-46	29	21	490	110	—	-30	—	-52	—
RA-MW-17A	-91	-40	-7	-5	-27	-89	—	-106	-34	-128	-79	74	-25	-11	-6	-39	54	-35	—	-41	—	-30	—
W85-6A	17	57	86	163	—	—	107	356	123	172	168	240	176	218	200	144	328	102	—	27	—	102	-57
W85-6B	19	76	72	159	—	—	79	340	70	164	161	236	177	229	165	117	357	107	—	24	—	101	-46
W92-16A	1	-14	30	110	110	-32	61	129	127	76	100	98	112	113	154	118	413	111	—	-164	—	88	—
W92-16B	-116	-61	-60	73	119	-103	30	253	113	71	60	116	114	121	152	151	459	134	—	-96	—	97	—
W97-18A	32	57	67	103	58	137	—	317	192	119	135	133	130	147	60	140	505	150	—	20	—	98	-81
W97-19A	71	94	72	218	69	149	—	311	96	71	156	233	128	205	127	155	609	112	—	30	—	144	-22
W97-19B	56	86	56	52	76	142	—	295	88	74	153	240	121	193	138	163	562	126	—	25	—	-46	-46
W98-21A	28	69	79	182	113	160	114	484	157	-55	165	243	135	228	183	196	453	155	—	21	—	105	-51
W98-21B	33	72	47	202	121	161	117	471	148	111	161	249	140	226	188	194	486	156	—	26	—	106	-48
W99-R5A	58	96	97	153	123	197	116	—	131	100	81	237	186	226	134	174	403	140	—	44	—	114	—
W99-R5B	58	78	74	201	92	204	111	—	122	92	90	239	180	213	167	162	414	141	—	34	—	104	—
RA-MW-11A	-384	-391	-316	-110	-241	-246	-216	-294	-671	-260	-263	-258	-259	—	—	—	—	—	—	—	—	—	—
RA-MW-11B	-394	-393	-332	-296	-289	-301	-278	-317	-303	-261	-287	-276	-313	—	—	—	—	—	—	—	—	—	—
RA-MW-13A	-155	-102	-97	-94	-204	-176	-93	-153	-121	-125	-144	-69	-101	—	—	—	—	—	—	—	—	—	—
RA-MW-13B	-129	-123	-104	-105	-125	-197	-85	-152	-125	-144	-166	-79	-99	—	—	—	—	—	—	—	—	—	—
RA-MW-13C	-136	-126	-116	-142	-33	-175	-112	-135	-137	-133	-143	-100	-140	—	—	—	—	—	—	—	—	—	—
RA-MW-14A	-77	-41	-54	-75	-82	-136	—	-80	-64	-104	-154	-25	-14	—	—	—	—	—	—	—	—	—	—
RA-MW-14B	-112	-95	-102	-112	-134	-133	—	-98	-144	-141	-129	-57	-64	—	—	—	—	—	—	—	—	—	—
W85-7A	68	83	57	197	116	113	127	246	131	186	160	—	175	—	—	—	—	—	—	—	—	—	—
W85-7B	59	73	66	215	132	146	167	259	141	187	161	—	189	—	—	—	—	—	—	—	—	—	—
W97-18B	57	63	60	188	83	152	—	233	187	123	118	—	—	—	—	—	—	—	—	—	—	—	—
W98-20A	52	116	84	219	116	171	—	366	143	91	166	—	153	—	—	—	—	—	—	—	—	—	—

(Table 3 continued)

Well Number	Sulfur (mg/L)																						
	Feb-04	Apr-04	Aug-04	May-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07	Jun-07	Sep-07	Dec-07	Sep-08	Sep-09	Sep-10	Sep-11	Oct-12	Apr-13	Dec-13	Apr-14	Oct-14	Sep-16
B85-4	23	150	31	87	20	103	21	59	67	59	75	—	23	39	32	33	13	20	—	32	—	25	76
B87-8	9	52	22	17	23	48	21	42	31	34	43	28	24	14	17	35	12	22	—	10	—	9	53
RA-MW-12A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	380	—
W85-6A	—	15	14	18	—	—	12	15	7	26	19	19	10	9	6	7	7	8	—	5	—	5	14
W98-21A	—	—	—	—	8	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
W99-R5A	5	6	4	5	6	7	6	5	5	5	5	5	6	6	6	5	5	5	—	5	—	5	13
RA-MW-11A	286	296	304	285	460	448	322	402	342	311	304	311	345	—	—	—	—	—	—	—	—	—	—
RA-MW-13A	743	246	324	372	363	310	213	111	207	107	130	148	122	—	—	—	—	—	—	—	—	—	—
RA-MW-14A	189	228	214	136	122	158	124	140	72	107	117	113	103	—	—	—	—	—	—	—	—	—	—
W85-7A	3	4	5	4	4	3	5	6	3	10	4	—	7	—	—	—	—	—	—	—	—	—	—
	Sulfate (mg/L)																						
	Feb-04	Apr-04	Aug-04	May-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07	Jun-07	Sep-07	Dec-07	Sep-08	Sep-09	Sep-10	Sep-11	Oct-12	Apr-13	Dec-13	Apr-14	Oct-14	Sep-16
B85-4	58	410	104	222	50	253	75	169	212	201	195	—	60	107	95	97	38	55	—	88	—	69	24
B87-8	21	137	73	170	63	125	74	117	98	113	120	87	61	39	54	102	35	63	—	28	—	25	17
RA-MW-12A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	973	—
W85-6A	5	36	44	44	—	—	35	41	21	85	51	59	27	20	19	20	22	22	—	14	—	13	4
W98-21A	—	—	—	—	19	25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
W99-R5A	12	12	13	15	13	15	18	14	14	16	14	15	16	17	19	15	16	15	—	13	—	14	4
RA-MW-11A	620	751	1040	736	1200	3040	993	1170	1120	954	795	995	989	—	—	—	—	—	—	—	—	—	—
RA-MW-13A	1960	712	1056	985	971	1980	682	323	657	362	331	451	342	—	—	—	—	—	—	—	—	—	—
RA-MW-14A	477	635	697	357	351	429	396	400	225	358	283	347	284	—	—	—	—	—	—	—	—	—	—
W85-7A	6	9	15	13	8	8	18	16	7	30	10	—	18	—	—	—	—	—	—	—	—	—	—
— = Not Analyzed mg/L = milligrams per liter mV = millivolts mS/cm = millisiemens per centimeter																							

**Table 4: Frontier Hard Chrome - Event 23 Ground Water Elevations - 12 September 2016**

Well Number	Time (24-Hr)	Casing Elevation (ft AMSL)	Depth to Water (ft)	Water level Elevation (ft AMSL)
W85-3A	—	26.40	—	—
W85-3B	1523	26.77	22.94	3.83
W97-18A <sup>1</sup>	1552	24.66	20.89	3.77
B85-4 <sup>1</sup>	1549	25.13	21.30	3.83
B87-8 <sup>1</sup>	1542	25.79	21.95	3.84
W92-16B	1537	25.51	21.74	3.77
W92-16A	1538	25.62	21.85	3.77
B85-3 <sup>1</sup>	1533	24.90	21.07	3.83
W85-7A <sup>1</sup>	1607	26.22	22.48	3.74
W85-7B <sup>1</sup>	1608	26.41	22.67	3.74
W97-19A <sup>2,3</sup>	1630	22.45	18.77	3.68
W97-19B <sup>2,3</sup>	1632	21.72	18.10	3.62
W98-20A <sup>1,3</sup>	1614	26.62	22.69	3.93
W85-6A <sup>1,3</sup>	1550	25.90	22.12	3.78
W85-6B <sup>1</sup>	1600	25.85	22.08	3.77
W98-21B <sup>1</sup>	1624	27.05	23.28	3.77
W98-21A <sup>1</sup>	1622	26.79	23.09	3.70
W99-R5A	1640	32.26	28.58	3.68
W99-R5B	1641	32.33	28.64	3.69
USGS 14144700 <sup>4</sup>	Daily Average for 9/12/2016			3.40

1 = Casing elevation surveyed by Minister-Glaeser Surveying Inc. on November 30, 2007

2 = Two different elevation datum's have been used at Frontier Hard Chrome. Weston (12/03) Long-Term Monitoring plan has applied a correction factor (+3.76 feet) using the City of Vancouver's benchmark #108 located near FHC site.

3 = anomalous groundwater elevation measurement; not used in flow direction and gradient calculations

4 = Stage height of the Columbia River corrected to the NGVD 1929 (add 1.82 feet) for September 12, 2016

AMSL = Above Mean Sea Level

ft = feet

USGS = United States Geological Survey

— = Could not measure water level elevation due to well not having been located.

**Table 5: Event 23 Quality Assurance Sample Results**

Well Number	Duplicate Sample ID	Field Sample Concentration	Duplicate Sample Concentration	Relative Percent Difference
<b>Total Chromium (µg/L) (unfiltered)</b>				
B87-8	QA-3	8.82	12.5	34.5
W97-19A	QA-2	< 2.50	< 2.50	—
<b>Dissolved Chromium (µg/L) (field-filtered)</b>				
B87-8	QA-3	< 5.00	< 5.00	—
<b>Dissolved Hexavalent Chromium (µg/L) (field-filtered)</b>				
B87-8	QA-3	0.029 J	0.045	43.2
<b>Sulfate (mg/L)</b>				
W85-6A	QA-1	13.9	13.9	0.0

< # = analyte not detected above indicated laboratory reporting limit  
 mg/L = milligrams per liter  
 µg/L = micrograms per liter  
 — = not calculable

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# **APPENDICES**

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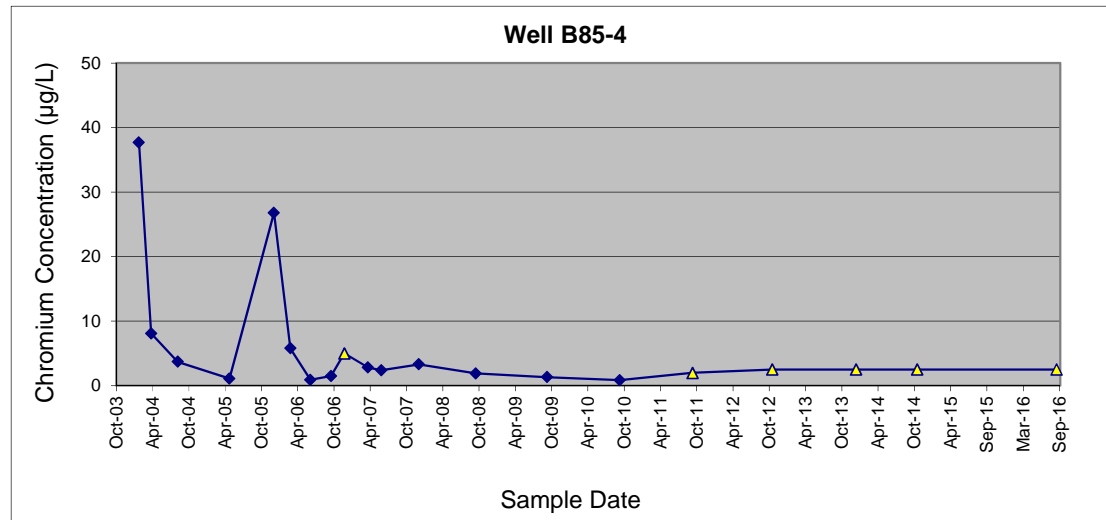
**APPENDIX A**

**GROUNDWATER CHROMIUM CONCENTRATION TRENDS**



## Well B85-4

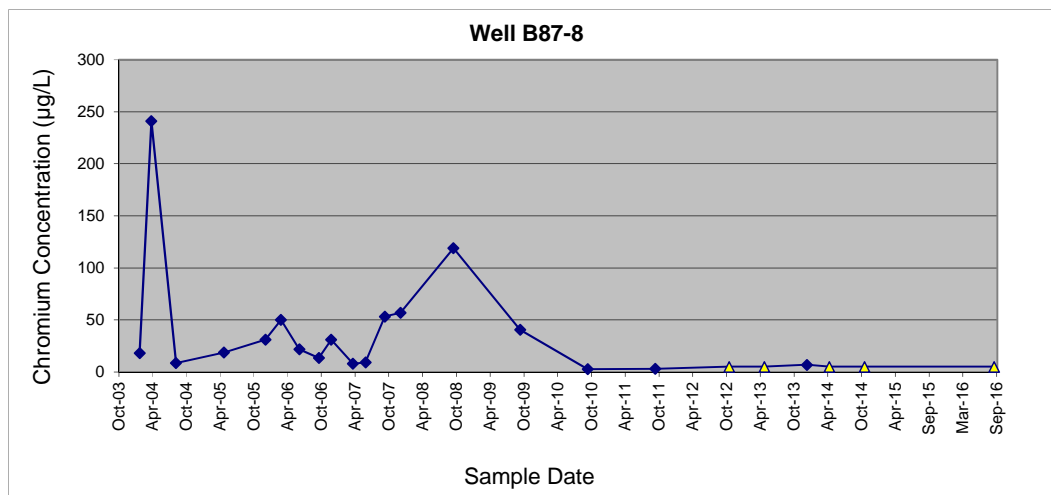
Sample Number	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AH4	Water	05-Feb-04	Chromium	37.7	µg/L		B85-4	Total	1.00
MJ2BK1	Water	07-Apr-04	Chromium	8.1	µg/L	J	B85-4	Total	0.00
MJ4738	Water	18-Aug-04	Chromium	3.7	µg/L	J	B85-4	Total	4.00
184246	Water	04-May-05	Chromium	1.1	µg/L		B85-4	Total	2.00
05504296	Water	13-Dec-05	Chromium	26.8	µg/L		B85-4	Total	5.70
104237	Water	06-Mar-06	Chromium	5.8	µg/L		B85-4	Total	3.90
244310	Water	14-Jun-06	Chromium	0.9	µg/L		B85-4	Total	0.30
394207	Water	27-Sep-06	Chromium	1.5	µg/L		B85-4	Total	1.00
494084	Water	02-Dec-06	Chromium	5	µg/L	U	B85-4	Total	0.00
134252	Water	30-Mar-07	Chromium	2.8	µg/L		B85-4	Total	1.40
234091	Water	06-Jun-07	Chromium	2.4	µg/L		B85-4	Total	2.10
504143	Water	11-Dec-07	Chromium	3.3	µg/L		B85-4	Total	1.40
8394097	Water	21-Sep-08	Chromium	1.9	µg/L		B85-4	Total	3.30
90906517	Water	15-Sep-09	Chromium	1.31	µg/L		B85-4	Total	0.71
1009065-08	Water	14-Sep-10	Chromium	0.86	µg/L		B85-4	Total	0.25
1009064-08	Water	13-Sep-11	Chromium	2	µg/L	U	B85-4	Total	1.11
1210057-11	Water	17-Oct-12	Chromium	2.50	µg/L	U	B85-4	Total	0.21
1312031-09	Water	11-Dec-13	Chromium	2.50	µg/L	U	B85-4	Total	0.15
1410031-13	Water	15-Oct-14	Chromium	2.50	µg/L	U	B85-4	Total	0.40
1609048-06	Water	13-Sep-16	Chromium	2.50	µg/L	U	B85-4	Total	1.22



Notes: Where a dissolved concentration is noted, the listed NTU value is the pre-filtering value.  
 Highlighted cells and data points (i.e., yellow triangles) represent 'non-detect' results  
 µg/L = micrograms per liter  
 J = estimated result  
 U = analyte not detected above laboratory reporting limit

## Well B87-8

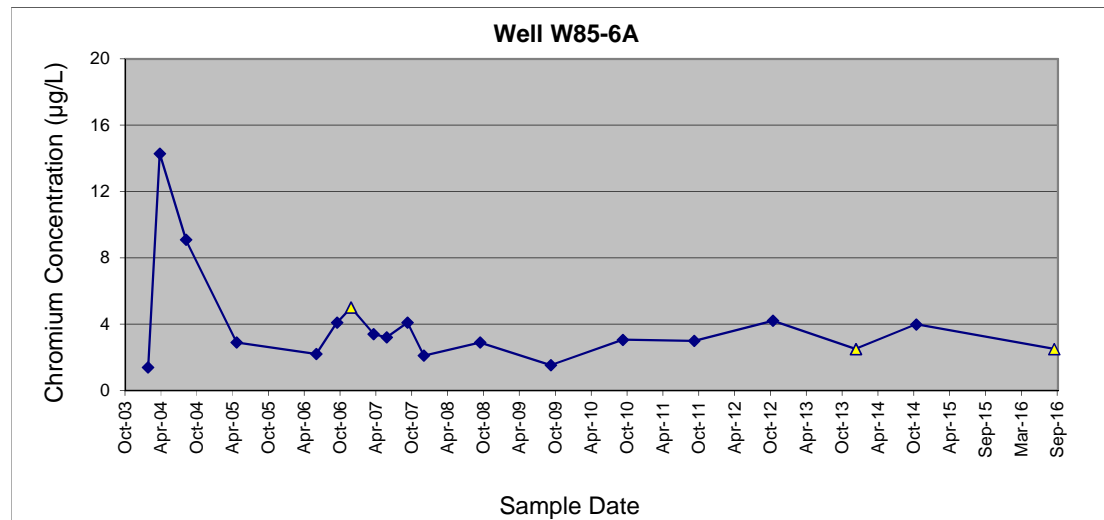
Sample Number	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AG9	Water	04-Feb-04	Chromium	18.2	µg/L		B87-8	Total	2.00
MJ2BK0	Water	07-Apr-04	Chromium	241	µg/L		B87-8	Total	8.00
MJ4737	Water	18-Aug-04	Chromium	8.5	µg/L	J	B87-8	Dissolved	36.00
184247	Water	04-May-05	Chromium	18.8	µg/L		B87-8	Total	6.50
05504297	Water	13-Dec-05	Chromium	31	µg/L		B87-8	Total	5.10
104236	Water	06-Mar-06	Chromium	50	µg/L		B87-8	Total	8.00
244308	Water	14-Jun-06	Chromium	21.8	µg/L		B87-8	Total	3.00
394204	Water	27-Sep-06	Chromium	13.4	µg/L		B87-8	Dissolved	13.00
494082	Water	02-Dec-06	Chromium	31	µg/L		B87-8	Total	0.10
134251	Water	30-Mar-07	Chromium	7.8	µg/L		B87-8	Dissolved	11.00
234089	Water	06-Jun-07	Chromium	9.2	µg/L		B87-8	Dissolved	0.90
384552	Water	18-Sep-07	Chromium	53.3	µg/L		B87-8	Dissolved	2.10
504144	Water	11-Dec-07	Chromium	56.9	µg/L		B87-8	Dissolved	8.40
8394098	Water	21-Sep-08	Chromium	119	µg/L		B87-8	Dissolved	13.00
90906520	Water	16-Sep-09	Chromium	40.5	µg/L		B87-8	Dissolved	16.70
1009065-20	Water	15-Sep-10	Chromium	2.71	µg/L		B87-8	Dissolved	6.60
1009064-10	Water	14-Sep-11	Chromium	3	µg/L		B87-8	Dissolved	2.54
1210057-13	Water	17-Oct-12	Chromium	5.00	µg/L	U	B87-8	Dissolved	7.47
1304072-01	Water	25-Apr-13	Chromium	5.00	µg/L	U	B87-8	Dissolved	5.40
1312031-08	Water	11-Dec-13	Chromium	6.85	µg/L		B87-8	Dissolved	1.65
1404040-01	Water	10-Apr-14	Chromium	5.00	µg/L	U	B87-8	Dissolved	2.40
1410031-19	Water	16-Oct-14	Chromium	5.00	µg/L	U	B87-8	Dissolved	1.09
1609048-13	Water	15-Sep-16	Chromium	5.00	µg/L	U	B87-8	Dissolved	2.75



Notes: Where a dissolved concentration is noted, the listed NTU value is the pre-filtering value.  
 Highlighted cells and data points (i.e., yellow triangles) represent 'non-detect' results  
 µg/L = micrograms per liter  
 J = estimated result  
 U = analyte not detected above laboratory reporting limit

## Well W85-6A

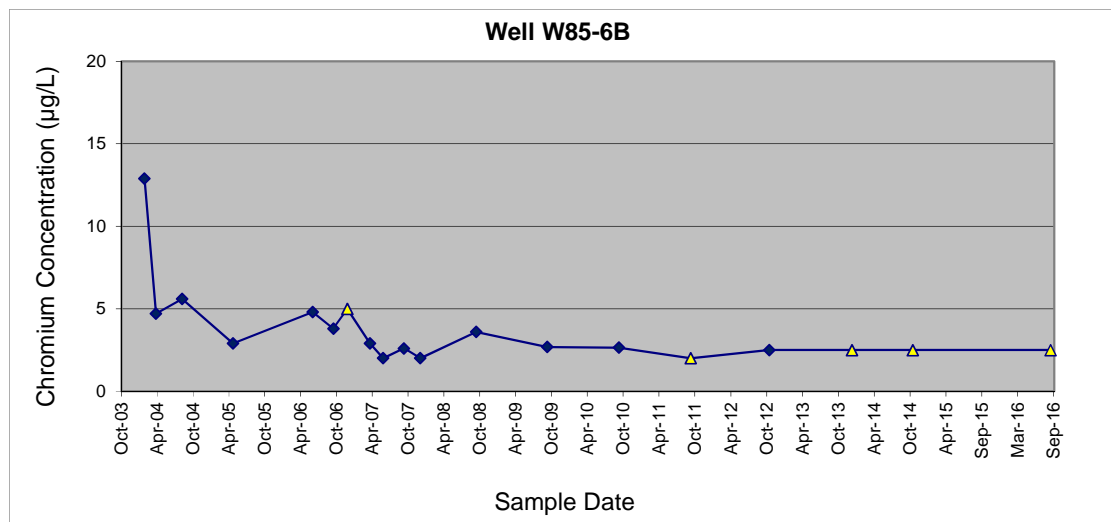
Sample Number	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ8	Water	09-Feb-04	Chromium	1.4	µg/L	J	W85-6A	Total	No Data
MJ2BL0	Water	08-Apr-04	Chromium	14.3	µg/L		W85-6A	Total	0.00
MJ4747	Water	19-Aug-04	Chromium	9.1	µg/L	J	W85-6A	Total	<10
184235	Water	04-May-05	Chromium	2.9	µg/L		W85-6A	Total	1.00
244284	Water	12-Jun-06	Chromium	2.2	µg/L		W85-6A	Total	0.70
394182	Water	25-Sep-06	Chromium	4.1	µg/L		W85-6A	Total	0.10
494113	Water	05-Dec-06	Chromium	5	µg/L	U	W85-6A	Total	2.00
134245	Water	30-Mar-07	Chromium	3.4	µg/L		W85-6A	Total	0.50
234072	Water	05-Jun-07	Chromium	3.2	µg/L		W85-6A	Total	0.20
384545	Water	18-Sep-07	Chromium	4.1	µg/L		W85-6A	Total	0.60
504132	Water	10-Dec-07	Chromium	2.1	µg/L		W85-6A	Total	0.50
8394083	Water	20-Sep-08	Chromium	2.9	µg/L		W85-6A	Total	0.20
90906501	Water	15-Sep-09	Chromium	1.53	µg/L		W85-6A	Total	0.64
1009065-03	Water	15-Sep-10	Chromium	3.06	µg/L		W85-6A	Total	0.15
1009064-03	Water	13-Sep-11	Chromium	3	µg/L		W85-6A	Total	0.61
1210057-03	Water	16-Oct-12	Chromium	4.21	µg/L		W85-6A	Total	0.14
1312031-03	Water	10-Dec-13	Chromium	2.50	µg/L	U	W85-6A	Total	0.03
1410031-03	Water	14-Oct-14	Chromium	3.99	µg/L		W85-6A	Total	0.09
1609048-02	Water	13-Sep-16	Chromium	2.50	µg/L	U	W85-6A	Total	0.98



Notes: Where a dissolved concentration is noted, the listed NTU value is the pre-filtering value.  
 Highlighted cells and data points (i.e., yellow triangles) represent 'non-detect' results  
 µg/L = micrograms per liter  
 J = estimated result  
 U = analyte not detected above laboratory reporting limit

### Well W85-6B

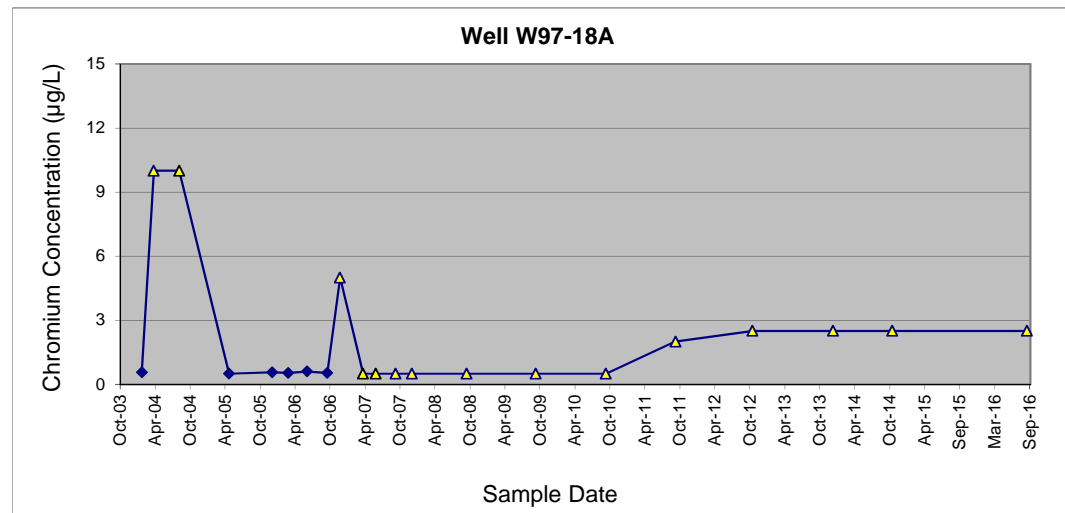
Sample Number	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ9	Water	09-Feb-04	Chromium	12.9	µg/L		W85-6B	Total	No Data
MJ2BL1	Water	08-Apr-04	Chromium	4.7	µg/L	J	W85-6B	Total	0.00
MJ4748	Water	19-Aug-04	Chromium	5.6	µg/L	J	W85-6B	Total	5.00
184236	Water	04-May-05	Chromium	2.9	µg/L		W85-6B	Total	1.00
244286	Water	12-Jun-06	Chromium	4.8	µg/L		W85-6B	Total	49.00
394183	Water	25-Sep-06	Chromium	3.8	µg/L		W85-6B	Total	14.00
494114	Water	05-Dec-06	Chromium	5	µg/L	U	W85-6B	Total	9.00
134246	Water	30-Mar-07	Chromium	2.9	µg/L		W85-6B	Total	4.60
234073	Water	05-Jun-07	Chromium	2.0	µg/L		W85-6B	Total	1.80
384546	Water	18-Sep-07	Chromium	2.6	µg/L		W85-6B	Total	1.30
504133	Water	10-Dec-07	Chromium	2	µg/L		W85-6B	Total	0.30
8394081	Water	20-Sep-08	Chromium	3.6	µg/L		W85-6B	Total	0.20
90906502	Water	15-Sep-09	Chromium	2.69	µg/L		W85-6B	Total	0.35
1009065-05	Water	14-Sep-10	Chromium	2.65	µg/L		W85-6B	Total	0.30
1009064-05	Water	13-Sep-11	Chromium	2	µg/L	U	W85-6B	Total	0.54
1210057-05	Water	16-Oct-12	Chromium	2.50	µg/L		W85-6B	Total	0.24
1312031-05	Water	10-Dec-13	Chromium	2.50	µg/L	U	W85-6B	Total	0.06
1410031-05	Water	14-Oct-14	Chromium	2.50	µg/L	U	W85-6B	Total	0.05
1609048-01	Water	13-Sep-16	Chromium	2.50	µg/L	U	W85-6B	Total	0.98



Notes: Where a dissolved concentration is noted, the listed NTU value is the pre-filtering value.  
 Highlighted cells and data points (i.e., yellow triangles) represent 'non-detect' results  
 µg/L = micrograms per liter  
 J = estimated result  
 U = analyte not detected above laboratory reporting limit

## Well W97-18A

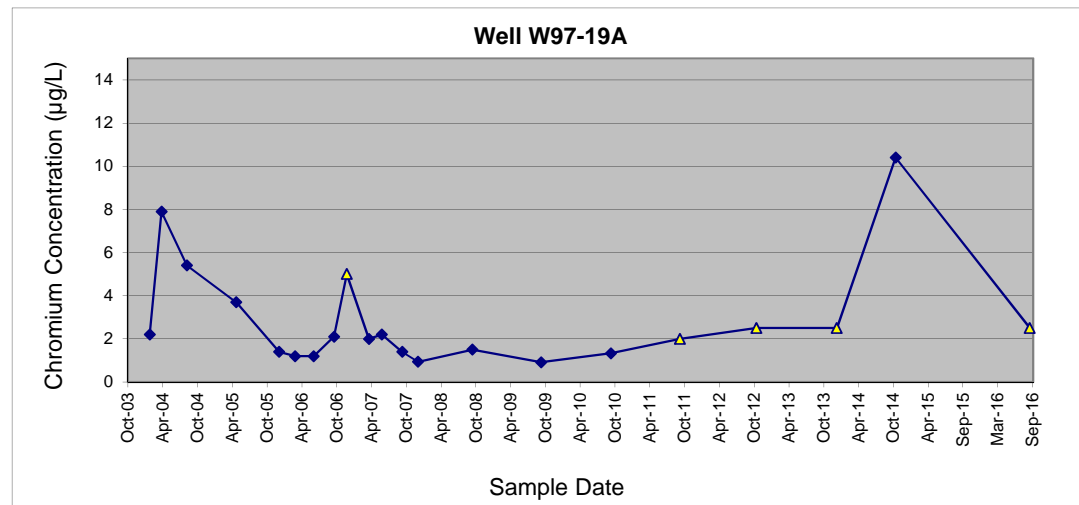
Sample Number	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AH5	Water	05-Feb-04	Chromium	0.56	µg/L	J	W97-18A	Total	14.00
MJ2BK2	Water	07-Apr-04	Chromium	10	µg/L	U	W97-18A	Total	0.00
MJ4739	Water	18-Aug-04	Chromium	10	µg/L	U	W97-18A	Total	5.00
184244	Water	04-May-05	Chromium	0.5	µg/L		W97-18A	Total	1.00
05504300	Water	14-Dec-05	Chromium	0.56	µg/L		W97-18A	Total	4.00
104256	Water	08-Mar-06	Chromium	0.53	µg/L		W97-18A	Total	0.00
244298	Water	13-Jun-06	Chromium	0.6	µg/L		W97-18A	Total	9.00
394209	Water	27-Sep-06	Chromium	0.53	µg/L		W97-18A	Total	6.00
494080	Water	02-Dec-06	Chromium	5	µg/L	U	W97-18A	Total	1.00
134269	Water	01-Apr-07	Chromium	0.5	µg/L	U	W97-18A	Total	8.50
234095	Water	06-Jun-07	Chromium	0.5	µg/L	U	W97-18A	Total	0.60
384555	Water	18-Sep-07	Chromium	0.5	µg/L	U	W97-18A	Total	7.70
504142	Water	11-Dec-07	Chromium	0.5	µg/L	U	W97-18A	Total	3.10
8394097	Water	21-Sep-08	Chromium	0.5	µg/L	U	W97-18A	Total	0.90
90906512	Water	16-Sep-09	Chromium	0.5	µg/L	U	W97-18A	Total	0.35
1009065-16	Water	16-Sep-10	Chromium	0.5	µg/L	U	W97-18A	Total	<10
1009064-09	Water	13-Sep-11	Chromium	2	µg/L	U	W97-18A	Total	0.88
1210057-14	Water	17-Oct-12	Chromium	2.50	µg/L	U	W97-18A	Total	0.37
1312031-11	Water	11-Dec-13	Chromium	2.50	µg/L	U	W97-18A	Total	0.05
1410031-15	Water	15-Oct-14	Chromium	2.50	µg/L	U	W97-18A	Total	0.08
1609048-09	Water	14-Sep-16	Chromium	2.50	µg/L	U	W97-18A	Total	1.05



Notes: Where a dissolved concentration is noted, the listed NTU value is the pre-filtering value.  
 Highlighted cells and data points (i.e., yellow triangles) represent 'non-detect' results  
 µg/L = micrograms per liter  
 J = estimated result  
 U = analyte not detected above laboratory reporting limit

## Well W97-19A

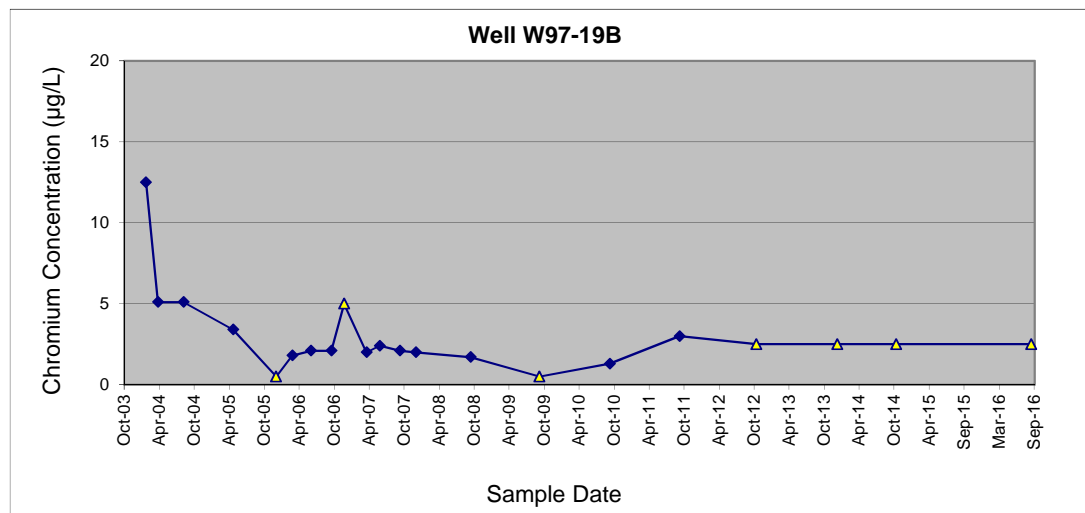
Sample Number	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ0	Water	06-Feb-04	Chromium	2.2	µg/L	J	W97-19A	Total	7.00
MJ2BK4	Water	08-Apr-04	Chromium	7.9	µg/L	J	W97-19A	Total	2.00
MJ4749	Water	19-Aug-04	Chromium	5.4	µg/L	J	W97-19A	Total	8.00
184242	Water	04-May-05	Chromium	3.7	µg/L		W97-19A	Total	1.80
05504303	Water	14-Dec-05	Chromium	1.4	µg/L		W97-19A	Total	0.00
104259	Water	08-Mar-06	Chromium	1.2	µg/L		W97-19A	Total	1.00
244296	Water	13-Jun-06	Chromium	1.2	µg/L		W97-19A	Total	1.00
394211	Water	27-Sep-06	Chromium	2.1	µg/L		W97-19A	Total	0.40
494095	Water	03-Dec-06	Chromium	5.0	µg/L	U	W97-19A	Total	1.00
134239	Water	29-Mar-07	Chromium	2.0	µg/L		W97-19A	Total	3.30
234077	Water	05-Jun-07	Chromium	2.2	µg/L		W97-19A	Total	1.80
384556	Water	19-Sep-07	Chromium	1.4	µg/L		W97-19A	Total	1.90
504149	Water	11-Dec-07	Chromium	0.94	µg/L		W97-19A	Total	1.00
8394084	Water	20-Sep-08	Chromium	1.5	µg/L		W97-19A	Total	1.90
90906505	Water	14-Sep-09	Chromium	0.92	µg/L		W97-19A	Total	3.23
1009065-01	Water	14-Sep-10	Chromium	1.33	µg/L		W97-19A	Total	3.00
1009064-01	Water	12-Sep-11	Chromium	2	µg/L	U	W97-19A	Total	0.70
1210057-01	Water	15-Oct-12	Chromium	2.50	µg/L	U	W97-19A	Total	0.27
1312031-06	Water	10-Dec-13	Chromium	2.50	µg/L	U	W97-19A	Total	0.00
1410031-02	Water	13-Oct-14	Chromium	10.4	µg/L		W97-19A	Total	0.58
1609048-10	Water	14-Sep-16	Chromium	2.50	µg/L	U	W97-19A	Total	2.14



Notes: Where a dissolved concentration is noted, the listed NTU value is the pre-filtering value.  
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µg/L = micrograms per liter  
J = estimated result  
U = analyte not detected above laboratory reporting limit

## Well W97-19B

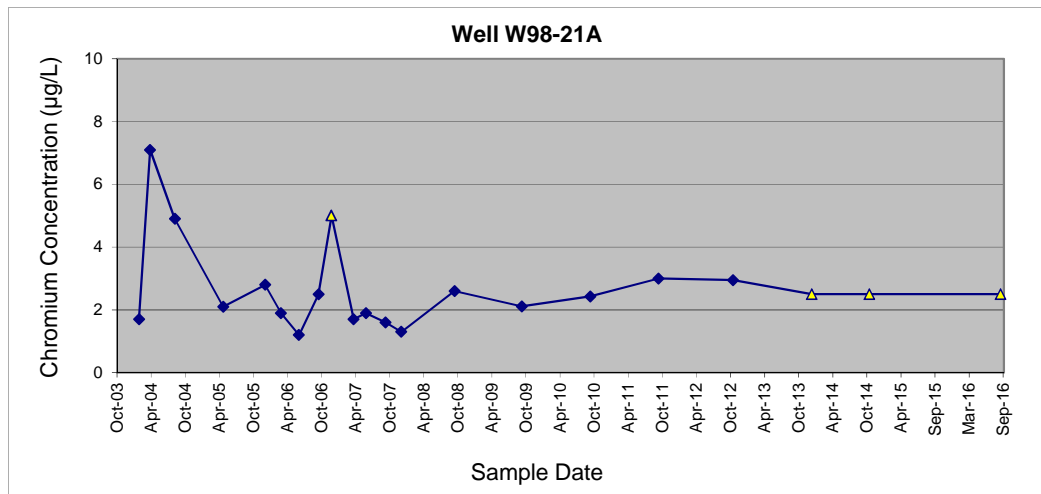
Sample Number	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ1	Water	06-Feb-04	Chromium	12.5	µg/L	J	W97-19B	Total	0.00
MJ2BK5	Water	08-Apr-04	Chromium	5.1	µg/L	J	W97-19B	Total	1.00
MJ4750	Water	19-Aug-04	Chromium	5.1	µg/L	J	W97-19B	Total	3.00
184243	Water	04-May-05	Chromium	3.4	µg/L		W97-19B	Total	1.00
05504304	Water	14-Dec-05	Chromium	0.5	µg/L	U	W97-19B	Total	0.00
104260	Water	08-Mar-06	Chromium	1.8	µg/L		W97-19B	Total	5.00
244297	Water	13-Jun-06	Chromium	2.1	µg/L		W97-19B	Total	0.50
394212	Water	27-Sep-06	Chromium	2.1	µg/L		W97-19B	Total	1.00
494096	Water	03-Dec-06	Chromium	5.0	µg/L	U	W97-19B	Total	1.00
134240	Water	29-Mar-07	Chromium	2.0	µg/L		W97-19B	Total	6.90
234078	Water	05-Jun-07	Chromium	2.4	µg/L		W97-19B	Total	1.90
384557	Water	19-Sep-07	Chromium	2.1	µg/L		W97-19B	Total	0.20
504150	Water	11-Dec-07	Chromium	2.0	µg/L		W97-19B	Total	4.70
8394085	Water	20-Sep-08	Chromium	1.7	µg/L		W97-19B	Total	0.20
90906506	Water	14-Sep-09	Chromium	0.5	µg/L	U	W97-19B	Total	0.50
1009065-02	Water	14-Sep-10	Chromium	1.3	µg/L		W97-19B	Total	0.20
1009064-02	Water	12-Sep-11	Chromium	3	µg/L		W97-19B	Total	0.54
1210057-02	Water	15-Oct-12	Chromium	2.50	µg/L	U	W97-19B	Total	0.37
1312031-07	Water	10-Dec-13	Chromium	2.50	µg/L	U	W97-19B	Total	3.83
1410031-01	Water	13-Oct-14	Chromium	2.50	µg/L	U	W97-19B	Total	1.34
1609048-12	Water	14-Sep-16	Chromium	2.50	µg/L	U	W97-19B	Total	3.85



Notes: Where a dissolved concentration is noted, the listed NTU value is the pre-filtering value.  
 Highlighted cells and data points (i.e., yellow triangles) represent 'non-detect' results  
 µg/L = micrograms per liter  
 J = estimated result  
 U = analyte not detected above laboratory reporting limit

## Well W98-21A

Sample Number	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ6	Water	09-Feb-04	Chromium	1.7	µg/L	J	W98-21A	Total	No Data
MJ2BK8	Water	08-Apr-04	Chromium	7.1	µg/L	J	W98-21A	Total	0.00
MJ4743	Water	19-Aug-04	Chromium	4.9	µg/L	J	W98-21A	Total	0.00
184237	Water	04-May-05	Chromium	2.1	µg/L		W98-21A	Total	1.30
05504309	Water	14-Dec-05	Chromium	2.8	µg/L		W98-21A	Total	0.10
104261	Water	08-Mar-06	Chromium	1.9	µg/L		W98-21A	Total	0.00
244282	Water	12-Jun-06	Chromium	1.2	µg/L		W98-21A	Total	0.30
394185	Water	25-Sep-06	Chromium	2.5	µg/L		W98-21A	Total	0.20
494098	Water	03-Dec-06	Chromium	5	µg/L	U	W98-21A	Total	0.10
134261	Water	31-Mar-07	Chromium	1.7	µg/L		W98-21A	Total	0.20
234074	Water	05-Jun-07	Chromium	1.9	µg/L		W98-21A	Total	0.90
384547	Water	18-Sep-07	Chromium	1.6	µg/L		W98-21A	Total	0.20
504146	Water	11-Dec-07	Chromium	1.3	µg/L		W98-21A	Total	2.60
8394082	Water	20-Sep-08	Chromium	2.6	µg/L		W98-21A	Total	0.10
90906503	Water	15-Sep-09	Chromium	2.11	µg/L		W98-21A	Total	0.72
1009065-13	Water	15-Sep-10	Chromium	2.43	µg/L		W98-21A	Total	0.15
1009064-14	Water	14-Sep-11	Chromium	3	µg/L		W98-21A	Total	0.59
1210057-09	Water	16-Oct-12	Chromium	2.95	µg/L		W98-21A	Total	0.23
1312031-12	Water	11-Dec-13	Chromium	2.50	µg/L	U	W98-21A	Total	0.01
1410031-09	Water	14-Oct-14	Chromium	2.50	µg/L	U	W98-21A	Total	0.15
1609048-08	Water	14-Sep-16	Chromium	2.50	µg/L	U	W98-21A	Total	0.72

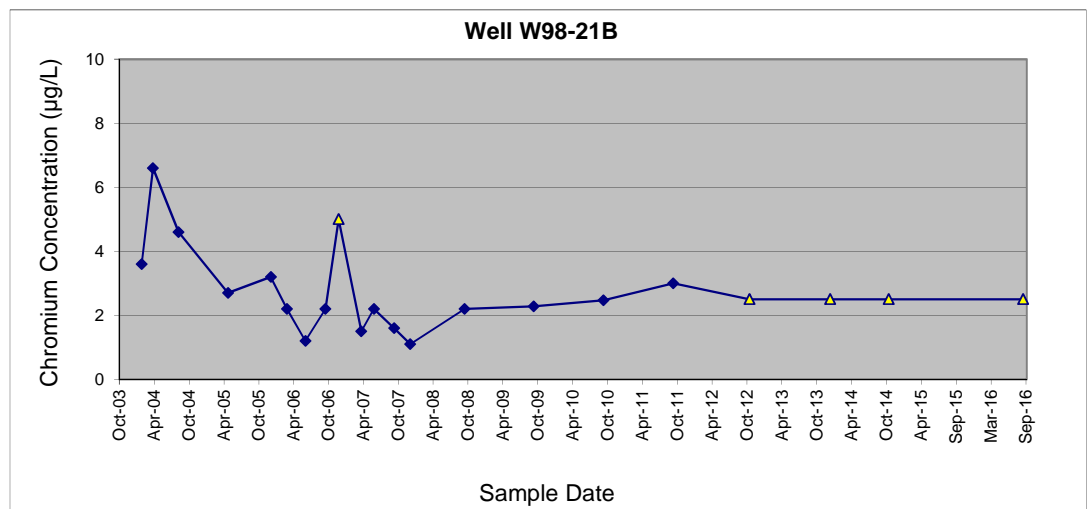


Notes: Where a dissolved concentration is noted, the listed NTU value is the pre-filtering value.  
Highlighted cells and data points (i.e., yellow triangles) represent 'non-detect' results  
µg/L = micrograms per liter  
J = estimated result  
U = analyte not detected above laboratory reporting limit



## Well W98-21B

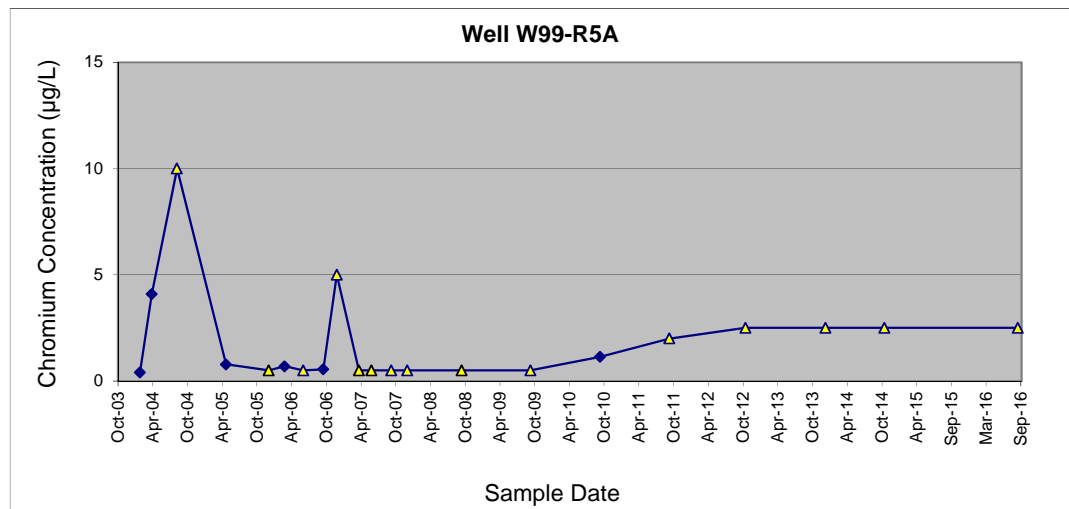
Sample Number	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ7	Water	09-Feb-04	Chromium	3.6	µg/L	J	W98-21B	Total	No Data
MJ2BK9	Water	08-Apr-04	Chromium	6.6	µg/L	J	W98-21B	Total	0.00
MJ4744	Water	19-Aug-04	Chromium	4.6	µg/L	J	W98-21B	Total	5.00
184238	Water	04-May-05	Chromium	2.7	µg/L		W98-21B	Total	0.50
05504310	Water	14-Dec-05	Chromium	3.2	µg/L		W98-21B	Total	0.00
104262	Water	08-Mar-06	Chromium	2.2	µg/L		W98-21B	Total	0.00
244283	Water	12-Jun-06	Chromium	1.2	µg/L		W98-21B	Total	0.30
394186	Water	25-Sep-06	Chromium	2.2	µg/L		W98-21B	Total	0.10
494099	Water	03-Dec-06	Chromium	5	µg/L	U	W98-21B	Total	0.20
134262	Water	31-Mar-07	Chromium	1.5	µg/L		W98-21B	Total	0.10
234075	Water	05-Jun-07	Chromium	2.2	µg/L		W98-21B	Total	0.20
384548	Water	18-Sep-07	Chromium	1.6	µg/L		W98-21B	Total	0.20
504147	Water	11-Dec-07	Chromium	1.1	µg/L		W98-21B	Total	1.70
8394083	Water	20-Sep-08	Chromium	2.2	µg/L		W98-21B	Total	0.40
90906504	Water	15-Sep-09	Chromium	2.28	µg/L		W98-21B	Total	0.76
1009065-14	Water	15-Sep-10	Chromium	2.47	µg/L		W98-21B	Total	0.45
1009064-15	Water	14-Sep-11	Chromium	3	µg/L		W98-21B	Total	0.61
1210057-08	Water	16-Oct-12	Chromium	2.50	µg/L	U	W98-21B	Total	0.16
1312031-13	Water	11-Dec-13	Chromium	2.50	µg/L	U	W98-21B	Total	0.00
1410031-08	Water	14-Oct-14	Chromium	2.50	µg/L	U	W98-21B	Total	0.03
1609048-07	Water	14-Sep-16	Chromium	2.50	µg/L	U	W98-21B	Total	0.76



Notes: Where a dissolved concentration is noted, the listed NTU value is the pre-filtering value.  
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µg/L = micrograms per liter  
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U = analyte not detected above laboratory reporting limit

## Well W99-R5A

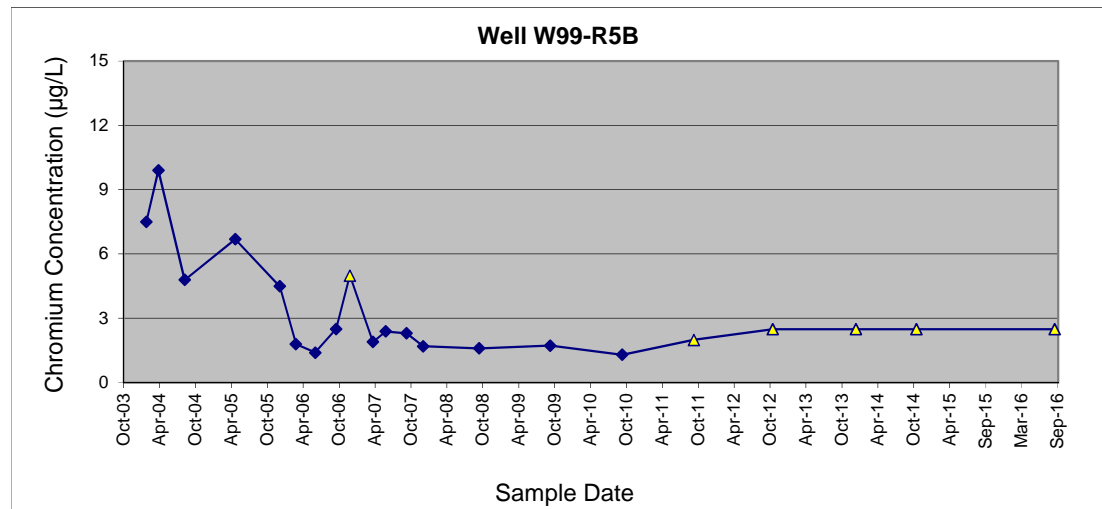
Sample Number	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ3	Water	07-Feb-04	Chromium	0.41	µg/L	J	W99-R5A	Total	0.00
MJ2BL3	Water	09-Apr-04	Chromium	4.1	µg/L	J	W99-R5A	Total	0.00
MJ4745	Water	19-Aug-04	Chromium	10	µg/L	U	W99-R5A	Total	10.00
184230	Water	03-May-05	Chromium	0.79	µg/L		W99-R5A	Total	1.00
05504305	Water	14-Dec-05	Chromium	0.5	µg/L	U	W99-R5A	Total	0.00
104230	Water	06-Mar-06	Chromium	0.7	µg/L		W99-R5A	Total	0.00
244280	Water	12-Jun-06	Chromium	0.5	µg/L	U	W99-R5A	Total	1.00
394180	Water	25-Sep-06	Chromium	0.55	µg/L		W99-R5A	Total	1.00
494115	Water	05-Dec-06	Chromium	5	µg/L	U	W99-R5A	Total	1.00
134264	Water	31-Mar-07	Chromium	0.5	µg/L	U	W99-R5A	Total	0.30
234060	Water	04-Jun-07	Chromium	0.5	µg/L	U	W99-R5A	Total	0.40
384530	Water	17-Sep-07	Chromium	0.5	µg/L	U	W99-R5A	Total	1.00
504130	Water	10-Dec-07	Chromium	0.5	µg/L	U	W99-R5A	Total	0.50
8394086	Water	20-Sep-08	Chromium	0.5	µg/L	U	W99-R5A	Total	0.40
90906507	Water	15-Sep-09	Chromium	0.5	µg/L	U	W99-R5A	Total	0.22
1009065-07	Water	14-Sep-10	Chromium	1.14	µg/L		W99-R5A	Total	0.10
1009064-07	Water	13-Sep-11	Chromium	2	µg/L	U	W99-R5A	Total	0.54
1210057-06	Water	16-Oct-12	Chromium	2.50	µg/L	U	W99-R5A	Total	0.23
1312031-01	Water	10-Dec-13	Chromium	2.50	µg/L	U	W99-R5A	Total	0.03
1410031-07	Water	14-Oct-14	Chromium	2.50	µg/L	U	W99-R5A	Total	0.00
1609048-05	Water	13-Sep-16	Chromium	2.50	µg/L	U	W99-R5A	Total	--



Notes: Where a dissolved concentration is noted, the listed NTU value is the pre-filtering value.  
 Highlighted cells and data points (i.e., yellow triangles) represent 'non-detect' results  
 µg/L = micrograms per liter  
 J = estimated result  
 U = analyte not detected above laboratory reporting limit

## Well W99-R5B

Sample Number	Matrix	Sample Date	Analyte	Conc.	Units	Qualifier	Station Location	Notes	NTU
MJ2AJ5	Water	07-Feb-04	Chromium	7.5	µg/L	J	W99-R5B	Total	0.00
MJ2BL4	Water	09-Apr-04	Chromium	9.9	µg/L	J	W99-R5B	Total	0.00
MJ4746	Water	19-Aug-04	Chromium	4.8	µg/L	J	W99-R5B	Total	8.00
184231	Water	03-May-05	Chromium	6.7	µg/L		W99-R5B	Total	2.30
05504306	Water	14-Dec-05	Chromium	4.5	µg/L		W99-R5B	Total	2.10
104231	Water	06-Mar-06	Chromium	1.8	µg/L		W99-R5B	Total	0.00
244281	Water	12-Jun-06	Chromium	1.4	µg/L		W99-R5B	Total	3.00
394181	Water	25-Sep-06	Chromium	2.5	µg/L		W99-R5B	Total	1.00
494116	Water	05-Dec-06	Chromium	5	µg/L	U	W99-R5B	Total	1.00
134265	Water	31-Mar-07	Chromium	1.9	µg/L		W99-R5B	Total	10.00
234061	Water	04-Jun-07	Chromium	2.4	µg/L		W99-R5B	Total	0.70
384531	Water	17-Sep-07	Chromium	2.3	µg/L		W99-R5B	Total	1.60
504130	Water	10-Dec-07	Chromium	1.7	µg/L		W99-R5B	Total	2.00
8394087	Water	20-Sep-08	Chromium	1.6	µg/L		W99-R5B	Total	0.80
90906508	Water	15-Sep-09	Chromium	1.73	µg/L		W99-R5B	Total	0.24
1009065-06	Water	14-Sep-10	Chromium	1.3	µg/L		W99-R5B	Total	0.20
1009064-06	Water	13-Sep-11	Chromium	2	µg/L	U	W99-R5B	Total	0.90
1210057-07	Water	16-Oct-12	Chromium	2.50	µg/L	U	W99-R5B	Total	0.19
1312031-02	Water	10-Dec-13	Chromium	2.50	µg/L	U	W99-R5B	Total	0.00
1410031-06	Water	14-Oct-14	Chromium	2.50	µg/L	U	W99-R5B	Total	0.03
1609048-05	Water	13-Sep-16	Chromium	2.50	µg/L	U	W99-R5B	Total	--



Notes: Where a dissolved concentration is noted, the listed NTU value is the pre-filtering value.  
Highlighted cells and data points (i.e., yellow triangles) represent 'non-detect' results  
µg/L = micrograms per liter  
J = estimated result  
U = analyte not detected above laboratory reporting limit

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**APPENDIX B**  
**LABORATORY DATA SHEETS**

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**APPENDIX B-1**  
**CHROMIUM DATA SHEETS**

**Manchester Environmental Laboratory**  
7411 Beach Drive E, Port Orchard, Washington 98366

**Case Narrative - Metals**

October 6, 2016

Project: Frontier Hardchrome-Event 23-2016

Work Order: 1609048

Project

Manager: Balaraju, Panjini

By: Dean Momohara

**Summary**

The laboratory followed EPA 200.7 for the preparation and analysis of trace metals.

The analysis requested was evaluated by established regulatory quality assurance guidelines.

**Sample Information**

The samples were received at the Manchester Laboratory on 9/20/2016. The samples were received in good condition and were properly preserved. Thirteen samples were received and assigned laboratory identification numbers 01, 02 and 04 to 14.

**Holding Times**

The laboratory performed the analysis within its hold time.

**Calibration**

The instrument was calibrated following the appropriate method. All initial and continuing calibration verification checks were within the acceptance limits. All initial and continuing calibration verification and blank checks were within the acceptance limits. The instrument was calibrated with a NIST traceable standard and verified to be in calibration with a second source NIST traceable standard.

### **Method Blanks**

No analytically significant levels of analyte were detected in the method blanks associated with these samples.

### **Laboratory Control Samples**

The laboratory control sample recovery was within the acceptance limits.

### **Replicates**

The associated duplicate relative percent difference of samples with concentrations greater than 5 times the reporting limit was within the acceptance limits.

### **Matrix Spikes**

All matrix spike recoveries were within the acceptance limits.

### **Internal Standards**

NA

### **Other Quality Assurance Measures and Issues**

U - The analyte was not detected at or above the reported result.

**bold** - The analyte was present in the sample. (Visual Aid to locate detected compounds on report sheet.)

Please call Dean Momohara at (360) 871-8808 to further discuss this project.

cc: Project File

**Washington State Department of Ecology  
Manchester Environmental Laboratory  
Final Analysis Report for  
Chromium, total\_ICP**

**Project Name: Frontier Hardchrome-Event 23-2016**

**Project Officer: Balaraju, Panjini**

**Prep Method: EPA200.7**

**Analysis Method: EPA200.7**

**Work Order: 1609048**

**Prepared: 09/27/16**

**Matrix: Water**

**Analyte: Chromium**

**Batch ID: B16I180**

**Units: ug/L**

Sample #	Sample ID	Result	Qualifier	RL	MDL	Collected	Analyzed
1609048-01	W85-6B	2.50	U	2.50	0.990	09/13/16	10/04/16
1609048-02	W85-6A	2.50	U	2.50	0.990	09/13/16	10/04/16
1609048-04	W99-R5A	2.50	U	2.50	0.990	09/13/16	10/04/16
1609048-05	W99-R5B	2.50	U	2.50	0.990	09/13/16	10/04/16
1609048-06	B85-4	2.50	U	2.50	0.990	09/13/16	10/04/16
1609048-07	W98-21B	2.50	U	2.50	0.990	09/14/16	10/04/16
1609048-08	W98-21A	2.50	U	2.50	0.990	09/14/16	10/04/16
1609048-09	W97-18A	2.50	U	2.50	0.990	09/14/16	10/04/16
1609048-10	W97-19A	2.50	U	2.50	0.990	09/14/16	10/04/16
1609048-11	QA-2	2.50	U	2.50	0.990	09/14/16	10/04/16
1609048-12	W97-19B	2.50	U	2.50	0.990	09/14/16	10/04/16
1609048-13	B87-8	8.82		2.50	0.990	09/15/16	10/04/16
1609048-14	QA-3	12.5		2.50	0.990	09/15/16	10/04/16

**QC Results for Batch ID: B16I180**

Method Blank	Sample ID	Result	Qualifier	RL	MDL
B16I180-BLK1	Blank	2.50	U	2.50	0.990

Sample #	QC Sample	Result	Spike Level	Source Sample	Source Result	%Rec	%Rec Limits	RPD	RPD Limit
B16I180-BS1	LCS	4060	4000			101	85-115		
B16I180-BSD1	LCS Dup	4060	4000			101	85-115	0.03	20
B16I180-MS1	Matrix Spike	3970	4000	1609048-13	8.82	99	75-125		
B16I180-MSD1	Matrix Spike Dup	4060	4000	1609048-13	8.82	101	75-125	2	20

**Authorized by:** DM

**Release Date:** 10/6/16

**Page 2 of 2**



**Washington State Department of Ecology  
Manchester Environmental Laboratory  
Final Analysis Report for  
Dissolved Chromium**

**Project Name: Frontier Hardchrome-Event 23-2016**

**Project Officer: Balaraju, Panjini  
Work Order: 1609048  
Analyte: Chromium**

**Prep Method:  
Prepared: 09/27/16  
Batch ID: B16I182**

**Analysis Method: EPA200.7  
Matrix: Water  
Units: ug/L**

Sample #	Sample ID	Result	Qualifier	RL	MDL	Collected	Analyzed
1609048-13	B87-8	5.00	U	5.00	2.98	09/15/16	10/06/16
1609048-14	QA-3	5.00	U	5.00	2.98	09/15/16	10/06/16

**QC Results for Batch ID: B16I182**

Method Blank	Sample ID	Result	Qualifier	RL	MDL
B16I182-BLK1	Blank	5.00	U	5.00	2.98

Sample #	QC Sample	Result	Spike Level	Source Sample	Source Result	%Rec	%Rec Limits	RPD	RPD Limit
B16I182-BS1	LCS	2000	2000			100	85-115		
B16I182-BSD1	LCS Dup	2030	2000			101	85-115	1	20
B16I182-MS1	Matrix Spike	2010	2000	1609048-13	5.00 U	100	75-125		
B16I182-MSD1	Matrix Spike Dup	1970	2000	1609048-13	5.00 U	98	75-125	2	20

**Authorized by:** DM

**Release Date:** 10/6/16

**Page 1 of 2**



Page 2 of 2

MS/MSD

**Project Name/Reference # of QAPP for this project:** \_\_\_\_\_

[illegible]

Recorder:

[illegible]

Comments: (see page 1 of 2)

---

**APPENDIX B-2**  
**SULFATE DATA SHEETS**

**Manchester Environmental Laboratory**  
7411 Beach Drive E, Port Orchard, Washington 98366

**Case Narrative – General Chemistry**

September 29, 2016

Project: Frontier Hardchrome-Event 23-2016

Work Order: 1609048

Project  
Manager: Balaraju, Panjini

By: Dean Momohara

**Summary**

The laboratory analyzed the samples following EPA 300.0 for sulfate.

All analyses requested were evaluated by established regulatory quality assurance guidelines.

**Sample Information**

The samples were received at the Manchester Laboratory on 9/20/2016. The cooler was received within the proper temperature range of 0°C - 6°C. The samples were received in good condition. Five samples were received and assigned laboratory identification numbers 02 to 04, 06 and 13.

**Holding Times**

The laboratory performed the analysis within its hold time.

**Calibration**

The instrument was calibrated following the appropriate method. All initial and continuing calibration verification checks were within the acceptance limits. All initial and continuing blank checks were within the acceptance limits. The r-value was within the acceptance limits. All standard residuals were within acceptance limits. The instrument was calibrated with NIST traceable standards and verified to be in calibration with second source NIST traceable standards.

### **Method Blanks**

No analytically significant level of analyte was detected in the method blank associated with these samples.

### **Laboratory Control Samples**

The laboratory control sample recovery was within the acceptance limits.

### **Replicates**

The duplicate relative percent difference of samples with concentrations greater than 5 times the reporting limit was within the acceptance limits.

### **Matrix Spikes**

The matrix spike recovery was within the acceptance limits.

### **Other Quality Assurance Measures and Issues**

U - The analyte was not detected at or above the reported result.

**bold** - The analyte was present in the sample. (Visual Aid to locate detected compounds on report sheet.)

Please call Dean Momohara at (360) 871-8808 to further discuss this project.

cc: Project File

**Washington State Department of Ecology  
Manchester Environmental Laboratory  
Final Analysis Report for  
Sulfate**

**Project Name: Frontier Hardchrome-Event 23-2016**

**Project Officer: Balaraju, Panjini**

**Method: EPA300.0**

**Matrix: Water**

**Work Order: 1609048**

**Batch ID: B16I154**

**Units: mg/L**

**Analyte: Sulfate**

**Prepared: 09/22/16**

Sample #	Sample ID	Result	Qualifier	RL	MDL	Collected	Analyzed
1609048-02	W85-6A	13.9		0.30	0.03	09/13/16	09/23/16
1609048-03	QA-1	13.9		0.30	0.03	09/13/16	09/23/16
1609048-04	W99-R5A	12.6		0.30	0.03	09/13/16	09/23/16
1609048-06	B85-4	76.2		1.20	0.12	09/13/16	09/23/16
1609048-13	B87-8	53.3		0.60	0.06	09/15/16	09/23/16

**QC Results for Batch ID: B16I154**

Method Blank	Sample ID	Result	Qualifier	RL	MDL
B16I154-BLK1	Blank	0.30	U	0.30	0.03

Sample #	QC Sample	Result	Spike Level	Source Sample	Source Result	%Rec	%Rec Limits	RPD	RPD Limit
B16I154-MS1	Matrix Spike	16.4	2.50	1609048-03	13.9	99	75-125		
B16I154-DUP1	Duplicate	13.9		1609048-02	13.9			0.008	20
B16I154-BS1	LCS	4.93	5.00			99	90-110		

**Authorized by:** DM

**Release Date:** 9/29/16

**Page 1 of 1**

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**APPENDIX B-3**  
**DISSOLVED SULFUR DATA SHEETS**



**Washington State Department of Ecology**  
**Manchester Environmental Laboratory**

7411 Beach Drive East, Port Orchard, Washington 98366

October 21, 2016

Subject: **Frontier Hardchrome**

Contract Laboratory: TestAmerica

Project Officer: Panjini Balaraju

By: Joel C. Bird

## *Sulfur*

### **Summary**

The samples were collected on September 13, 2016. They arrived at TestAmerica on September 20, 2016.

There are no temperature requirements for metals in water. The samples were verified to be at pH <2 by TestAmerica.

Sample 1609048-2, W85-6A contained sulfur at 4300 ug/L, Sample 1609048-04, W-99-R5A contained sulfur at 3800 ug/L, Sample 1609048-06, B85-4 contained sulfur at 24000 ug/L and Sample 1609-48-13, B87-8 contained sulfur at 17000 ug/L.

### **Analytical Methods**

These samples were prepared and analyzed using EPA method 200.7. Routine QA/QC procedures were performed. All calibration standards were within criteria.

### **Blanks**

No sulfur was detected in the method blank above the reporting limit.

### **Holding Times**

The samples were analyzed within the method holding time of 6 months from collection.

### **Duplicate Samples**

No duplicate analyses were performed on these samples.

### **Matrix Spike and Matrix Spike Duplicate**

The percent recoveries and/or relative percent difference of the MS/MSD performed on Sample 1609048-06, B85-4 were outside control limits. This was because the sample concentration in the sample was greater than four times the spike amount.

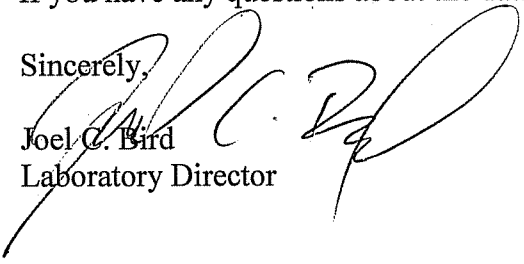
### **Laboratory Control Samples (LCS)**

Recoveries were within laboratory limits of 85% to 115%.

If you have any questions about the data results please do not hesitate to call me.

Sincerely,

Joel C. Bird  
Laboratory Director



# TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

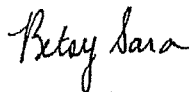
## ANALYTICAL REPORT

TestAmerica Laboratories, Inc.  
TestAmerica Denver  
4955 Yarrow Street  
Arvada, CO 80002  
Tel: (303)736-0100

TestAmerica Job ID: 280-88466-1  
Client Project/Site: Washington State Dept of Ecology-Sulfur

For:  
Washington State Dept of Ecology  
Manchester Environmental Laboratory  
7411 Beach Drive East  
Port Orchard, Washington 98366

Attn: Nancy Rosenbower



Authorized for release by:  
9/30/2016 5:54:13 PM

Betsy Sara, Project Manager II  
(303)736-0189  
betsy.sara@testamericainc.com

### LINKS

Review your project  
results through

**TotalAccess**

Have a Question?

**Ask  
The  
Expert**

Visit us at:

[www.testamericainc.com](http://www.testamericainc.com)

The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

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## Definitions/Glossary

Client: Washington State Dept of Ecology  
Project/Site: Washington State Dept of Ecology-Sulfur

TestAmerica Job ID: 280-88466-1

### Qualifiers

#### Metals

Qualifier	Qualifier Description
4	MS, MSD: The analyte present in the original sample is greater than 4 times the matrix spike concentration; therefore, control limits are not applicable.

### Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
α	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

## Case Narrative

Client: Washington State Dept of Ecology  
Project/Site: Washington State Dept of Ecology-Sulfur

TestAmerica Job ID: 280-88466-1

**Job ID: 280-88466-1**

**Laboratory: TestAmerica Denver**

**Narrative**

### CASE NARRATIVE

**Client: Washington State Dept of Ecology**

**Project: Washington State Dept of Ecology-Sulfur**

**Report Number: 280-88466-1**

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

#### Sample Receiving

The samples were received on 09/20/2016; the samples arrived in good condition, properly preserved and on ice. The temperature of the cooler at receipt was 0.1 C.

The cooler arrived without a custody seal. However, The tape on the cooler was intact and did not appear to have been tampered with. The client was notified on 9/23/2016.

#### Holding Times

The holding times were within established control limits.

#### Method Blanks

All Method Blanks were within established control limits.

#### Laboratory Control Samples (LCS)

All Laboratory Control Samples were within established control limits.

#### Matrix Spikes/Matrix Spike Duplicates (MS/MSD)

The percent recoveries and/or relative percent difference of the MS/MSD performed on sample 1609048-06 (B85-4) were outside control limits for Sulfur Method 200.7 because the sample concentration was greater than four times the spike amount. Because the corresponding Laboratory Control Sample and the Method Blank sample were within control limits, no corrective action was taken.

## Detection Summary

Client: Washington State Dept of Ecology  
Project/Site: Washington State Dept of Ecology-Sulfur

TestAmerica Job ID: 280-88466-1

Client Sample ID: 1609048-02 (W85-6A)

Lab Sample ID: 280-88466-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil	Fac	D	Method	Prep Type
Sulfur	4300		100	9.1	ug/L	1			200.7 Rev 4.4	Dissolved

Client Sample ID: 1609048-04 (W99-R5A)

Lab Sample ID: 280-88466-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil	Fac	D	Method	Prep Type
Sulfur	3800		100	9.1	ug/L	1			200.7 Rev 4.4	Dissolved

Client Sample ID: 1609048-06 (B85-4)

Lab Sample ID: 280-88466-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil	Fac	D	Method	Prep Type
Sulfur	24000		100	9.1	ug/L	1			200.7 Rev 4.4	Dissolved

Client Sample ID: 1609048-13 (B87-8)

Lab Sample ID: 280-88466-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil	Fac	D	Method	Prep Type
Sulfur	17000		100	9.1	ug/L	1			200.7 Rev 4.4	Dissolved

This Detection Summary does not include radiochemical test results.

TestAmerica Denver

## Method Summary

Client: Washington State Dept of Ecology  
Project/Site: Washington State Dept of Ecology-Sulfur

TestAmerica Job ID: 280-88466-1

Method	Method Description	Protocol	Laboratory
200.7 Rev 4.4	Metals (ICP)	EPA	TAL DEN

### Protocol References:

EPA = US Environmental Protection Agency

### Laboratory References:

TAL DEN = TestAmerica Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100



## Sample Summary

Client: Washington State Dept of Ecology  
Project/Site: Washington State Dept of Ecology-Sulfur

TestAmerica Job ID: 280-88466-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
280-88466-1	1609048-02 (W85-6A)	Water	09/13/16 12:00	09/20/16 12:25
280-88466-2	1609048-04 (W99-R5A)	Water	09/13/16 14:45	09/20/16 12:25
280-88466-3	1609048-06 (B85-4)	Water	09/13/16 16:55	09/20/16 12:25
280-88466-4	1609048-13 (B87-8)	Water	09/15/16 12:20	09/20/16 12:25

## Client Sample Results

Client: Washington State Dept of Ecology  
Project/Site: Washington State Dept of Ecology-Sulfur

TestAmerica Job ID: 280-88466-1

### Method: 200.7 Rev 4.4 - Metals (ICP) - Dissolved

Client Sample ID: 1609048-02 (W85-6A)

Date Collected: 09/13/16 12:00

Date Received: 09/20/16 12:25

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfur	4300		100	9.1	ug/L		09/26/16 07:50	09/27/16 20:53	1

Lab Sample ID: 280-88466-1

Matrix: Water

Client Sample ID: 1609048-04 (W99-R5A)

Date Collected: 09/13/16 14:45

Date Received: 09/20/16 12:25

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfur	3800		100	9.1	ug/L		09/26/16 07:50	09/27/16 20:55	1

Lab Sample ID: 280-88466-2

Matrix: Water

Client Sample ID: 1609048-06 (B85-4)

Date Collected: 09/13/16 16:55

Date Received: 09/20/16 12:25

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfur	24000		100	9.1	ug/L		09/26/16 07:50	09/27/16 20:58	1

Lab Sample ID: 280-88466-3

Matrix: Water

Client Sample ID: 1609048-13 (B87-8)

Date Collected: 09/15/16 12:20

Date Received: 09/20/16 12:25

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfur	17000		100	9.1	ug/L		09/26/16 07:50	09/27/16 21:07	1

Lab Sample ID: 280-88466-4

Matrix: Water

TestAmerica Denver

# QC Sample Results

Client: Washington State Dept of Ecology  
Project/Site: Washington State Dept of Ecology-Sulfur

TestAmerica Job ID: 280-88466-1

## Method: 200.7 Rev 4.4 - Metals (ICP)

Lab Sample ID: MB 280-343396/1-A

Matrix: Water

Analysis Batch: 344061

Client Sample ID: Method Blank

Prep Type: Total Recoverable

Prep Batch: 343396

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfur	ND		100	9.1	ug/L		09/26/16 07:50	09/27/16 20:48	1

Lab Sample ID: LCS 280-343396/2-A

Matrix: Water

Analysis Batch: 344061

Client Sample ID: Lab Control Sample

Prep Type: Total Recoverable

Prep Batch: 343396

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	Limits
Sulfur	2000	1860		ug/L		93	80 - 120

Lab Sample ID: 280-88466-3 MS

Matrix: Water

Analysis Batch: 344061

Client Sample ID: 1609048-06 (B85-4)

Prep Type: Dissolved

Prep Batch: 343396

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	Limits
Sulfur	24000		2000	26000	4	ug/L		115	80 - 120

Lab Sample ID: 280-88466-3 MSD

Matrix: Water

Analysis Batch: 344061

Client Sample ID: 1609048-06 (B85-4)

Prep Type: Dissolved

Prep Batch: 343396

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	Limits	RPD	Limit
Sulfur	24000		2000	26200	4	ug/L		125	80 - 120	1	20

TestAmerica Denver

## QC Association Summary

Client: Washington State Dept of Ecology  
Project/Site: Washington State Dept of Ecology-Sulfur

TestAmerica Job ID: 280-88466-1

### Metals

#### Prep Batch: 343396

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-88466-1	1609048-02 (W85-6A)	Dissolved	Water	200.7	
280-88466-2	1609048-04 (W99-R5A)	Dissolved	Water	200.7	
280-88466-3	1609048-06 (B85-4)	Dissolved	Water	200.7	
280-88466-4	1609048-13 (B87-8)	Dissolved	Water	200.7	
MB 280-343396/1-A	Method Blank	Total Recoverable	Water	200.7	
LCS 280-343396/2-A	Lab Control Sample	Total Recoverable	Water	200.7	
280-88466-3 MS	1609048-06 (B85-4)	Dissolved	Water	200.7	
280-88466-3 MSD	1609048-06 (B85-4)	Dissolved	Water	200.7	

#### Analysis Batch: 344061

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-88466-1	1609048-02 (W85-6A)	Dissolved	Water	200.7 Rev 4.4	343396
280-88466-2	1609048-04 (W99-R5A)	Dissolved	Water	200.7 Rev 4.4	343396
280-88466-3	1609048-06 (B85-4)	Dissolved	Water	200.7 Rev 4.4	343396
280-88466-4	1609048-13 (B87-8)	Dissolved	Water	200.7 Rev 4.4	343396
MB 280-343396/1-A	Method Blank	Total Recoverable	Water	200.7 Rev 4.4	343396
LCS 280-343396/2-A	Lab Control Sample	Total Recoverable	Water	200.7 Rev 4.4	343396
280-88466-3 MS	1609048-06 (B85-4)	Dissolved	Water	200.7 Rev 4.4	343396
280-88466-3 MSD	1609048-06 (B85-4)	Dissolved	Water	200.7 Rev 4.4	343396

## Lab Chronicle

Client: Washington State Dept of Ecology  
Project/Site: Washington State Dept of Ecology-Sulfur

TestAmerica Job ID: 280-88466-1

**Client Sample ID: 1609048-02 (W85-6A)**

**Lab Sample ID: 280-88466-1**

Date Collected: 09/13/16 12:00

Matrix: Water

Date Received: 09/20/16 12:25

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	200.7			50 mL	50 mL	343396	09/26/16 07:50	TEB	TAL DEN
Dissolved	Analysis	200.7 Rev 4.4		1			344061	09/27/16 20:53	CRR	TAL DEN

**Client Sample ID: 1609048-04 (W99-R5A)**

**Lab Sample ID: 280-88466-2**

Date Collected: 09/13/16 14:45

Matrix: Water

Date Received: 09/20/16 12:25

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	200.7			50 mL	50 mL	343396	09/26/16 07:50	TEB	TAL DEN
Dissolved	Analysis	200.7 Rev 4.4		1			344061	09/27/16 20:55	CRR	TAL DEN

**Client Sample ID: 1609048-06 (B85-4)**

**Lab Sample ID: 280-88466-3**

Date Collected: 09/13/16 16:55

Matrix: Water

Date Received: 09/20/16 12:25

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	200.7			50 mL	50 mL	343396	09/26/16 07:50	TEB	TAL DEN
Dissolved	Analysis	200.7 Rev 4.4		1			344061	09/27/16 20:58	CRR	TAL DEN

**Client Sample ID: 1609048-13 (B87-8)**

**Lab Sample ID: 280-88466-4**

Date Collected: 09/15/16 12:20

Matrix: Water

Date Received: 09/20/16 12:25

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	200.7			50 mL	50 mL	343396	09/26/16 07:50	TEB	TAL DEN
Dissolved	Analysis	200.7 Rev 4.4		1			344061	09/27/16 21:07	CRR	TAL DEN

**Laboratory References:**

TAL DEN = TestAmerica Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100

TestAmerica Denver

## Certification Summary

Client: Washington State Dept of Ecology  
Project/Site: Washington State Dept of Ecology-Sulfur

TestAmerica Job ID: 280-88466-1

### Laboratory: TestAmerica Denver

The certifications listed below are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Washington	State Program	10	C583	08-03-17

## Login Sample Receipt Checklist

Client: Washington State Dept of Ecology

Job Number: 280-88466-1

Login Number: 88466

List Source: TestAmerica Denver

List Number: 1

Creator: Woodworth, Sean P

Question	Answer	Comment
Radioactivity wasn't checked or is $\leq$ background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	False	Not present
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is $<6\text{mm}$ ( $1/4''$ ).	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

## TAL-4124-280 (0508)

**TestAmerica**  
THE LEADER IN ENVIRONMENTAL TESTING

**THE LEADER IN ENVIRONMENTAL TESTING**

280-88466 Chain of Custody

280-88466 Chain of Custody

Special Instructions/  
Conditions of Receipt



---

**APPENDIX B-4**  
**HEXAVALENT CHROMIUM DATA SHEETS**

**Washington State Department of Ecology**  
**Manchester Environmental Laboratory**  
7411 Beach Drive E, Port Orchard, Washington 98366

Date: October 21, 2016

Project: Frontier Hardchrome Event2

ECY LIMS Work Order #: 1609048

Contract Laboratory: Edge Analytical

Contract Lab Reference Number: 16-23094

Project Officer: Panjini Balaraju

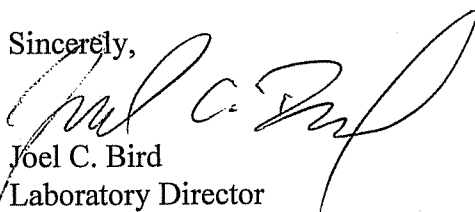
***Hexavalent Chromium Cr (VI) by EPA Method 218.9***

Enclosed are the results for samples collected on September 15, 2016. Both samples were filtered in the field and had an adjusted pH of 9 – 9.5. The samples were analyzed within 24 hours of sample receipt. Sample B87-8, 1609048-13 had a detection of Hexavalent Chromium at 0.029 ug/L. This amount was detected below the reporting limit or practical quantitation limit (PQL) of 0.030 ug/L. It is therefore reported “estimate” with a J qualifier as it was detected below the lowest point on the standard calibration curve. All 3 reagent blanks associated with the sample were non-detect. The value of 0.029 ug/L can be considered a valid result. Sample QA-3, 1609048-14 had a detection of Hexavalent Chromium at 0.045 ug/L.

Associated duplicate results were acceptable as were the MS/MSD ran on each sample. All other quality control samples analyzed with these samples were also found to be acceptable. All raw data associated with these samples has been reviewed and the data results have been verified as accurate.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

  
Joel C. Bird  
Laboratory Director

Data Review Checklist				
Question	Y	N	NA	Exceptions and action taken
Were all the samples analyzed for the requested parameters?	X			
Did sample arrive in a state of proper preservation (< 6 °C) at contract lab?	X			
Are the holding times within acceptable limits for preparation and analysis?	X			
Are all of the calibration and sample raw data present, including documentation (e.g. standards, run log, and instrument logs) complete?	X			
Are all of the analytes within acceptable limits for the Initial Calibration (ICAL)?	X			
Are all of the analytes within acceptable limits for the Initial Calibration Verification (ICV)? 90-110%	X			
Was a Continuing Calibration Verification (CCV) analyzed every 10 samples?	X			
Are all of the analytes for the Continuing Calibration Verification (CCV) within acceptable limits? 90% to 110%	X			
Was the Laboratory Control Sample (LCS) spiked with all target analytes and are percent recoveries within quality control (QC) limits? 85% to 115%	X			
Is one method blank analyzed per batch of 20 samples or less, and is it free of any positive results?	X			
Was a post spike performed on one of the samples, and was recovery within QC limits? (Standard was added to an aliquot of sample after extraction and just before analysis.) 85% to 115%	X			
Were the matrix spike and matrix spike duplicate (MS/MSD) spiked with all target analytes and are percent recoveries within QC limits? 85% to 115%	X			
Is the RPD between the MS and MSD and within QC limits? <20%	X			
If a Sample Duplicate was analyzed, is the RPD within QC limits? <25%	X			
Are the results correctly calculated, with proper units and within the linear range of the calibrations?	X			

NA – Not available/Not applicable.



Burlington, WA Corporate Laboratory (a)  
1620 S Walnut St - Burlington, WA 98233 - 800.755.9295 - 360.757.1400  
Bellingham, WA Microbiology (b)  
805 Orchard Dr Ste 4 - Bellingham, WA 98225 - 360.715.1212

Portland, OR Microbiology/Chemistry (c)  
9150 SW Pioneer Ct Ste W - Wilsonville, OR 97070 - 503.682.7802  
Corvallis, OR Microbiology/Chemistry (d)  
540 SW Third Street - Corvallis, OR 97333 - 541.753.4946  
Bend, OR Microbiology (e)  
20332 Empire Blvd Ste 4 - Bend, OR 97701 - 541.639.8425

Page 1 of 1

## Data Report

Client Name: Manchester Environmental Laboratory  
7411 Beach Drive East  
Port Orchard, WA 98366


Reference Number: **16-23094**  
Project: Frontier Hard Chrome-Event  
23 (FHC-E23)

Report Date: 9/19/16

Date Received: 9/16/16

Approved by: mvp

Authorized by:

  
Patrick Miller, MS  
QA Officer

Sample Description: 1609048-13 - B87-8										Sample Date: 9/15/16 12:20 pm			
Lab Number: 56456      Sample Comment:										Collected By: Brian Reilly			
CAS ID#	Parameter	Result	PQL	MDL	Units	DF	Method	Lab	Analyzed	Analyst	Batch	Comment	

18540-29-9	HEXAVALENT CHROMIUM	0.029 J	0.030	0.0016	ug/L	1.0	218.6	a	9/17/16	LJH	218.6_160917		
------------	---------------------	---------	-------	--------	------	-----	-------	---	---------	-----	--------------	--	--

Sample Description: 1609048-14 - QA-3										Sample Date: 9/15/16 12:30 pm			
Lab Number: 56457      Sample Comment:										Collected By: Brian Reilly			
CAS ID#	Parameter	Result	PQL	MDL	Units	DF	Method	Lab	Analyzed	Analyst	Batch	Comment	

18540-29-9	HEXAVALENT CHROMIUM	0.045	0.030	0.0016	ug/L	1.0	218.6	a	9/17/16	LJH	218.6_160917		
------------	---------------------	-------	-------	--------	------	-----	-------	---	---------	-----	--------------	--	--

### Notes:

ND = Not detected above the listed practical quantitation limit (PQL) or not above the Method Detection Limit (MDL), if requested.  
PQL = Practical Quantitation Limit is the lowest level that can be achieved within specified limits of precision and accuracy during routine laboratory operating conditions.  
D.F. - Dilution Factor

If you have any questions concerning this report contact us at the above phone number.

Form: cRsl\_2.rpt

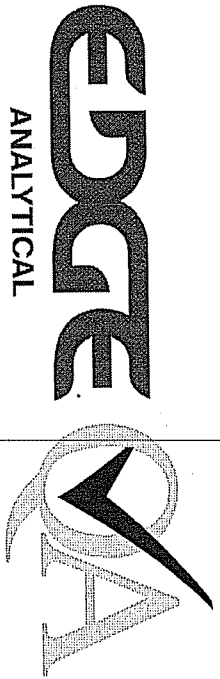


## Qualifier Definitions

Reference Number: 16-23094  
Report Date: 09/19/16

Qualifier	Definition
J	Indicates an estimated concentration. This occurs when an analyte concentration is below the calibration curve but is above the method detection limit.

Note: Some qualifier definitions found on this page may pertain to results or QC data which are not printed with this report.



Reference Number: **16-23094**  
Report Date: 9/19/2016

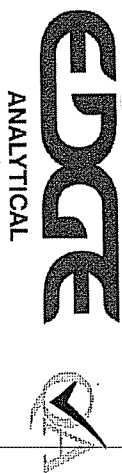
Page 1 of 2

**SAMPLE DEPENDENT  
QUALITY CONTROL REPORT**  
Duplicate, Matrix Spike/Matrix Spike Duplicate and Confirmation Result Report

Batch	Sample Analyte	Duplicate		Units	QC		Qualifier	Type	Comments
		Result	Result		%RPD	Limits			
Duplicate									
218.6_160917	56071 HEXAVALENT CHROMIUM	2.830	2.807	ug/L	0.8	0-20		DUP	

**%RPD = Relative Percent Difference**

NA = Indicates %RPD could not be calculated  
Matrix Spike (MS)/Matrix Spike Duplicate (MSD) analyses are used to determine the accuracy (MS) and precision (MSD) of an analytical method in a given sample matrix. Therefore, the usefulness of this report is limited to samples of similar matrices analyzed in the same analytical batch.  
Only Duplicate sample with detections are listed in this report  
Limits are intended for water matrices only. These criteria are for guidance only when reported with soils/solids.  
FORM: QC Dependenci



Batch	Sample	Analyte	Duplicate		Spike Conc	Units	Percent Recovery		Limits*	%RPD Limits*		QC	Qualifier	Type	Comments
			Result	Spike Result			MS	MSD							

### Laboratory Fortified Matrix (MS)

218.6\_160917

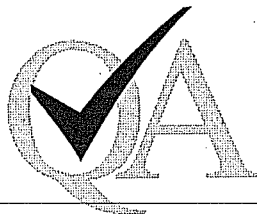
56456	HEXAVALENT CHROMIUM	0.029	0.313	0.317	0.300	ug/L	95	96	90-110	1.4	0-20			LFM	
56457	HEXAVALENT CHROMIUM	0.045	0.329	0.344	0.300	ug/L	95	100	90-110	5.1	0-20			LFM	

%RPD = Relative Percent Difference

NA = Indicates %RPD could not be calculated  
Matrix Spike (MS)/Matrix Spike Duplicate (MSD) analyses are used to determine the accuracy (MS) and precision (MSD) of an analytical method in a given sample matrix. Therefore, the usefulness of this report is limited to samples of similar matrices analyzed in the same analytical batch.

Only Duplicate sample with detections are listed in this report  
Limits are intended for water matrices only. These criteria are for guidance only when reported with soils/solids.

FORM: QC-Dependent.rpt

SAMPLE INDEPENDENT  
QUALITY CONTROL REPORT

Calibration Check

Reference Number: **16-23094**

Report Date: 09/19/16

Batch	Analyte	Result	True Value	Units	Method	%	QC		Comment
							Recovery	Limits*	
218.6_160917	o HEXAVALENT CHROMIUM	7.038	7.000	ug/L	218.6	101	85-115	CAL	LDR

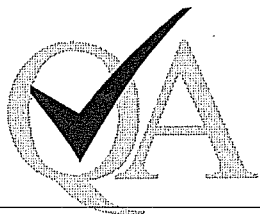
## \*Notation:

 $\% \text{ Recovery} = (\text{Result of Analysis}) / (\text{True Value}) * 100$ 

NA = Indicates % Recovery could not be calculated.

Limits are intended for water matrices only. These criteria are for guidance only when reported with soils/solids.



SAMPLE INDEPENDENT  
QUALITY CONTROL REPORT

Laboratory Fortified Blank

Reference Number: **16-23094**

Report Date: 09/19/16

Batch	Analyte	Result	True		Method	%	Recovery	Limits*	QC		Comment
			Value	Units					Qualifier	Type	
218.6_160917	1 HEXAVALENT CHROMIUM	0.248	0.250	ug/L	218.6	99	90-110		LFB		
	2 HEXAVALENT CHROMIUM	0.998	1.000	ug/L	218.6	100	90-110		LFB		
	3 HEXAVALENT CHROMIUM	0.500	0.500	ug/L	218.6	100	90-110		LFB		

\*Notation:

% Recovery = (Result of Analysis)/(True Value) \* 100

NA = Indicates % Recovery could not be calculated.

Limits are intended for water matrices only. These criteria are for guidance only when reported with soils/solids.



# SAMPLE INDEPENDENT QUALITY CONTROL REPORT

Low-Level Lab Fortified Blank

Reference Number: **16-23094**

Report Date: 09/19/16

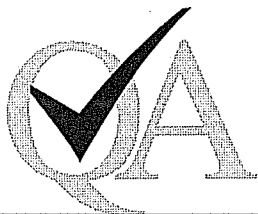
Batch	Analyte	Result	True		Method	%	QC		Comment
			Value	Units			Limits*	Qualifier Type	
218.6_160917	0 HEXAVALENT CHROMIUM	0.033	0.030	ug/L	218.6	110	50-150	LLFB	MRL

---

**\*Notation:** $\% \text{ Recovery} = (\text{Result of Analysis}) / (\text{True Value}) * 100$ 

NA = Indicates % Recovery could not be calculated.

Limits are intended for water matrices only. These criteria are for guidance only when reported with soils/solids.

SAMPLE INDEPENDENT  
QUALITY CONTROL REPORT

Laboratory Reagent Blank

Reference Number: **16-23094**

Report Date: 09/19/16

Batch	Analyte	Result	True		Method	%	QC	QC	Comment
			Value	Units		Recovery	Limits*	Qualifier	
218.6_160917	0 HEXAVALENT CHROMIUM	ND		ug/L	218.6		0-0		LRB
	1 HEXAVALENT CHROMIUM	ND		ug/L	218.6		0-0		LRB
	2 HEXAVALENT CHROMIUM	ND		ug/L	218.6		0-0		LRB

## \*Notation:

 $\% \text{ Recovery} = (\text{Result of Analysis}) / (\text{True Value}) * 100$ 

NA = Indicates % Recovery could not be calculated.

Limits are intended for water matrices only. These criteria are for guidance only when reported with soils/solids.



## SAMPLE INDEPENDENT QUALITY CONTROL REPORT

Quality Control Sample

Reference Number: **16-23094**

Report Date: 09/19/16

			True				%	QC	QC	
Batch	Analyte	Result	Value	Units	Method	Recovery	Limits*	Qualifier	Type	Comment
218.6 160917	0 HEXAVALENT CHROMIUM	1.193	1.160	ug/L	218.6	103	90-110		QCS	

---

**\*Notation:** $\% \text{ Recovery} = (\text{Result of Analysis}) / (\text{True Value}) * 100$ 

NA = Indicates % Recovery could not be calculated.

Limits are intended for water matrices only. These criteria are for guidance only when reported with soils/solids.

(Please complete all applicable shaded sections)

30300



ANALYTICAL

Main Lab (800-755-9296)

1620 South Wahu! St. Burlington, WA 98233  
 (360) 336-1620 / (800) 797-4740

**Microbiology (888-725-1212)**

805 W. Orchard Dr. Suite 4 Bellingham, WA 98225

**Wilsonville Lab (503-682-7802)**

9150 SW Pioneer Ct. Suite W Wilsonville, OR 97070

**Corvallis Lab (541-753-4946)**  
E/OCIA/7th Co Corvallis OD 67363

540 SW 3<sup>rd</sup> St. Corvallis, OR 97333

### Chain of Custody / Analysis Request

(Please complete all applicable shaded sections)


(F7C-E23)

### Instructions

- |   | Turn Around Time Required  |
|---|--|
| 1. Use one line per sample location.                            |  |
| 2. Be specific in analysis requests.                            |  |
| 3. (NEW) List each metal individually (NEW)                     | <input checked="" type="checkbox"/> Standard                       |
| 4. Check off analyses to be performed for each sample location. | <input type="checkbox"/> Half-time (50% surcharge)                 |
| 5. Enter number of containers.                                  | <input type="checkbox"/> Quickest (100% surcharge) Phone Call Req. |
|   | <input type="checkbox"/> Emergency (Phone Call Req.)               |

### Analyses Requested

<b>Instructions</b>					
1.	Use one line per sample Location.				
2.	Be specific in analysis requests.				
3.	List each metal individually. (NEW)	<input checked="" type="checkbox"/> Standard			
4.	Check off analyses to be performed for each sample Location.	<input type="checkbox"/> Half-time (50% surcharge) <input type="checkbox"/> Quickest (100% surcharge) Phone Call Req. <input type="checkbox"/> Emergency (Phone Call Req.)			
5.	Enter number of containers.				
Field ID	Location	Grab/ Comp.	Sample Matrix *	Date	Time
					218.6 (Cr+6)
Nun	Containers				
Special Instructions Conditions on Receipt					

  
 COA30300  
**16-23094**  
 56456 - 56457

Special Instructions  
Conditions on Receipt

16-23094  
56456 - 56457

56456 - 56457

[illegible]

**Sample Receipt Request (Must include FAX or Email)**

\* W - water  
DW - drinking water

SW - surface water  
GW - Ground water

WW - waste water  
S - soil

Other\_

Relinquished by

Date \_\_\_\_\_

Time

Received by

Date \_\_\_\_\_

Time

**Custody seals intact**

100

Sample temp 4.8 C satisfactory

**Samples received intact**

### Chain of custody & labels agree

Feed Ex

---

**APPENDIX C**

**RECONSTRUCTED MONITORING WELL ELEVATIONS**

## MONITORING WELL ASBUILT

FOR  
"GRAND CENTRAL"

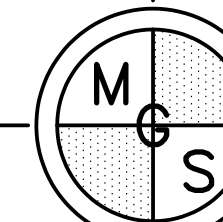
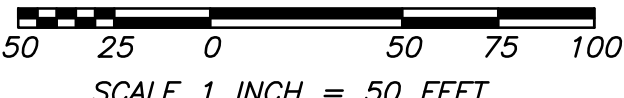
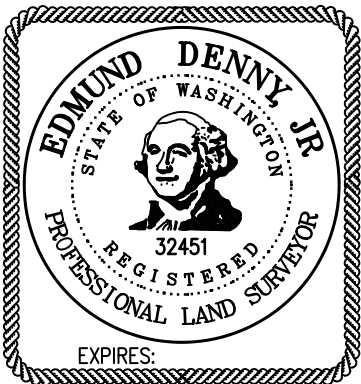
JOB NO.: 07-231  
DATA COLLECT: 11-30-07  
DRAWING DATE: 12-06-07

LEGEND:

 INDICATES MONITORING WELL

BENCH MARK-

VERTICAL DATUM IS CITY OF VANCOUVER BENCH MARK  
108, A BRASS DISC ON THE NORTHEAST CURB AT THE  
INTERSECTION OF E. 5TH STREET AND GRAND BOULEVARD.  
ELEVATION = 53.76 (NAVD 29)



**MINISTER—GLAESER**  
**SURVEYING INC.**  
2200 E. EVERGREEN BLVD.  
VANCOUVER, WA 98661  
(360) 694-3313

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**APPENDIX D**  
**DATA VALIDATION MEMORANDUM**



## APPENDIX D

### EXCEPTION SUMMARY FOR LABORATORY DATA QUALITY ASSURANCE REVIEW

#### DATA SUMMARY

The laboratory data quality assurance review and validation of analytical results for 14 water samples, Project Number 1609048, collected between September 13 and 15, 2016 from the Frontier Hard Chrome site has been completed. This review incorporates sample results for other metals for assessment purposes, but applies only to the following analyses:

- Total and dissolved chromium by Washington State Department of Ecology's (Ecology) Manchester Environmental Laboratory (MEL), of Port Orchard, Washington, following EPA Method 200.7 – inductively-coupled plasma/atomic emission spectrometry (ICP-AES).
- Sulfate by Ecology's MEL of Port Orchard, Washington, following EPA Method 300.0 – determination of inorganic anions by ion chromatography.
- Dissolved sulfur by TestAmerica Laboratories, Inc. - Denver of Arvada, Colorado, following EPA Method 200.7 – inductively-coupled plasma/atomic emission spectrometry (ICP-AES).
- Hexavalent chromium by EDGE Analytical of Burlington, Washington, following EPA Method 218.6 – determination of dissolved hexavalent chromium in water by ion chromatography.

Quality assurance/quality control (QA/QC) reviews of laboratory procedures were performed on an ongoing basis by MEL. A data review was performed by MEL's QA section on laboratory quality control results to ensure they met method quality objectives for the project. Data review followed the format outlined in the *National Functional Guidelines for Inorganic Data Review* (EPA 2004), modified to include specific criteria specified in the *Frontier Hard Chrome Long-Term Monitoring Plan* (Work Plan; Weston 2004). Raw laboratory data including calibrations, sample login forms, sample preparation logs and bench sheets, mass spectral tuning data, and raw instrument data were not available for this review.

This is an exception summary. All laboratory quality assurance results as applicable (e.g., holding times; blank sample analysis, matrix spike/duplicate spike analysis, and laboratory control sample analysis results) supplied to WESTON for the analyses met acceptance criteria specified in the Work Plan (Weston 2004) with any exceptions detailed in this summary.

Precision was evaluated as relative percent differences (RPD) between duplicate and total chromium, dissolved chromium, dissolved hexavalent chromium, and sulfate concentrations. Field duplicates for total recoverable chromium (Sample Nos. 1609048-14 and 1609048-11) were collected from monitoring wells B87-8 and W97-19A, respectively. A field duplicate for dissolved chromium and dissolved hexavalent chromium (Sample No. 1609048-14) was collected from monitoring well B87-8. A field duplicate for sulfate (Sample No. 1609048-03) was collected from monitoring well W85-6A. A field duplicate was not collected for dissolved sulfur analysis.

Acceptance criteria specified in the QAPP (RPD less than or equal to 20%) were met for all duplicate analyses with the exception of total chromium and dissolved hexavalent chromium results for duplicate samples B87-8 and QA-3. The RPD for total chromium between field sample 1609048-13 (collected from B87-8) and its associated duplicate sample, 1609048-14 (QA-3), was calculated as 34.5%. However, the sample results for total chromium were less than 5 times the Reporting Limit. Therefore, data qualification is not required. During previous events, field duplicate samples were not collected from monitoring well B87-8; however, observations of samples collected from this well reported black particulates suspended in the water column that may account for the significant variation in the total (i.e., unfiltered) chromium results. The field duplicate result for total chromium for samples collected from RA-MW-12A, which was not sampled during the 2016 sampling event, has frequently exceeded acceptance criteria. The June 2014 Event 21 Monitoring Report notes that the relatively high range of total recoverable chromium concentrations collected from well RA-MW-12A is most likely attributable to variations in the amount of suspended particulates within the individual samples as noted in field observations. Field duplicates collected during previous sampling events where particulates were not observed have historically met QAPP duplicate sample RPD requirements. The RPD for dissolved hexavalent chromium between field sample 1609048-13 (collected from B87-8) and its associated duplicate sample, 1609048-14 (QA-3), was calculated as 43.2%. However, the sample result for field sample 1609048-13 was below the reporting limit and is an estimated value. There is no qualification required for dissolved hexavalent chromium sample results.

Field sample 1609048-10 (collected from monitoring well W97-19A) and its associated duplicate sample, 1609048-11 (QA-2), both exhibited total chromium concentrations below the laboratory reporting limit; therefore, the RPD between the field sample and the duplicate sample was not calculable for total chromium. The RPD for sulfate between field sample 1609048-02 (collected from W85-6A) and its associated duplicate sample, 1609048-03 (QA-1), was calculated as 0.0% due to the analytical results being equivalent.

The matrix spike duplicate recovery for sulfur in sample 1609048-06, which was collected from well B85-4, was 125%, which is outside the control limit of 80-120

## **DATA QUALIFICATION**

The RPD for dissolved hexavalent chromium between field sample 1609048-13 (collected from B87-8) and its associated duplicate sample, 1609048-14 (QA-3), was calculated as 43.2%. However, the sample result for field sample 1609048-13 was below the reporting limit and is an estimated value. There is no qualification required for dissolved hexavalent chromium sample results.

The matrix spike duplicate recovery for sulfur in sample 1609048-06, which was collected from well B85-4, was 125%, which is outside the control limit of 80-120%. Based upon Laboratory Control Sample Matrix Spike results, which had % recoveries within control limits, and as the matrix spike duplicate % recovery was not significantly outside of control limits, the diluted sample result did not require additional qualification.

No additional QA/QC exceptions were noted in the data review associated with the analysis of total recoverable, dissolved, and hexavalent chromium. Upon consideration of the data qualifications noted above and the project data quality objectives specified in the QAPP, the data are ACCEPTABLE for use.

## DATA QUALIFIERS

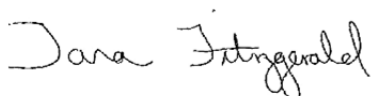
**If required, any data qualifiers applied by the laboratory have been removed from the data summary sheets and superseded by data validation qualifiers.**

No data validation qualifiers were used to modify the data quality and usefulness of individual analytical results.

## DATA ASSESSMENT

Data review was performed by an experienced quality assurance chemist independent of the analytical laboratory and not directly involved in the project.

This is to certify that I have examined the analytical data and based on the information provided to me by the laboratory, in my professional judgment the data are acceptable for use except where qualified with qualifiers that modify the usefulness of those individual values.



---

Tara Fitzgerald  
Project Chemist

November 30, 2016

Date

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**APPENDIX E**

**MONITORING WELL CONSTRUCTION AND FIELD DATA SHEETS**

**Monitoring Well Construction Information**  
**Frontier Hard Chrome, Vancouver, Washington**

Well No.	Well Dia. (in)	Well Depth (feet)	Top of Screen Depth (ft)	Bottom of Screen Depth (ft)	Screen Length (ft)	Date Installed	Northing	Easting	Casing Elev. (feet)*	Top of Monument Elev. (feet)*
Monitoring Wells										
B85-3	2	29.5	24	29	5	10/7/85	112605.90	1091462.16	24.9	25.6 <sup>+</sup>
B85-4	2	26.5	21.5	26.5	5	10/10/85	112324.18	1091631.89	25.38	26.18
B85-6	2	29.5	24.5	29.5	5	10/15/85	112532.34	1091705.95	24.64	25.2 <sup>+</sup>
B87-8	4	29.5	24.5	29.5	5	1/13/87	112344.00	1091529.10	25.95	26.21
MW-1	2	34.5	19.2	34.0	14.8	5/21/02	112441.82	1091607.30	25.69	26.00
MW-3	2	37.3	21.7	36.5	14.8	5/20/02	112433.24	1091610.54	25.69	26.04
MW-4	2	35.2	19.7	34.5	14.8	5/22/02	112424.34	1091616.25	25.62	25.84
MW-7	2	47.2	41.6	46.4	4.8	5/20/02	112442.22	1091620.89	25.66	25.93
MW-20	2	27.3	21.9	26.6	4.7	5/22/02	112462.35	1091613.99	25.75	26.09
MW-21	2	35.6	30.4	35.1	4.7	5/22/02	112462.58	1091617.43	25.77	26.14
RA-MW-11A	2	27.8	22.9	27.6	4.7	5/2/03	112482.47	1091514.95	26.17	26.45
RA-MW-11B	2	33.1	28.3	32.9	4.6	5/1/03	112479.76	1091510.42	26.17	26.45
RA-MW-12A	2	28.1	23.2	27.9	4.7	5/1/03	112479.92	1091544.46	26.17	26.47
RA-MW-12B	2	33.0	28.3	32.8	4.5	5/1/03	112480.85	1091541.13	26.16	26.53
RA-MW-12C	2	39.2	34.5	39.0	4.5	4/30/03	112484.97	1091542.35	26.01	26.48
RA-MW-13A	2	27.3	22.5	27.1	4.6	6/3/03	112449.48	1091594.97	25.69	25.96
RA-MW-13B	2	32.1	27.3	31.9	4.6	6/3/03	112448.39	1091592.13	25.61	25.86
RA-MW-13C	2	39.7	34.6	39.5	4.9	6/3/03	112453.33	1091595.78	25.55	25.97
RA-MW-14A	2	25.3	20.3	25.1	4.8	6/4/03	112447.10	1091654.85	25.06	25.44
RA-MW-14B	2	30.3	25.5	30.1	4.6	6/4/03	112444.72	1091652.41	25.00	25.38
RA-MW-15A	2	26.6	22.1	26.6	4.5	5/30/03	112412.99	1091561.36	25.76	26.11
RA-MW-15B	2	32.7	27.7	32.5	4.8	5/30/03	112413.29	1091557.10	25.79	26.10
RA-MW-16A	2	26.8	22.2	26.7	4.5	6/2/03	112413.87	1091630.20	25.14	25.47
RA-MW-16B	2	32.7	27.9	32.5	4.6	6/2/03	112414.70	1091626.50	25.45	25.68
RA-MW-17A	2	26.4	21.7	26.2	4.5	6/5/03	112478.04	1091624.86	25.96	26.23
W85-2B	4	50	45	49	5	9/10/85	112427.94	1091417.06	25.77	26.09
W85-3A	2	29.5	19.5	29.5	10	9/5/85	112824.50	1091509.69	26.40	26.97
W85-3B	4	49	44	49	5	9/4/85	112824.23	1091514.26	26.77	27.14
W85-6A <sup>#</sup>	2	27	17	27	10	10/12/85	111924.04	1091489.91	25.38	25.8 <sup>+</sup>
W85-6B <sup>#</sup>	4	49	44	49	5	10/11/85	111912.90	1091495.31	25.24	25.8 <sup>+</sup>
W85-7A <sup>#</sup>	2	26.5	16.5	26.5	10	10/22/85	111916.01	1090984.92	22.83	23.1 <sup>+</sup>
W85-7B <sup>#</sup>	2	49	44	49	5	10/21/85	111917.15	1090952.50	23.0	23.1 <sup>+</sup>
W86-10B	4	50	43.8	48.8	5	12/12/86	112510.41	1093365.77	26.8	26.6 <sup>+</sup>
W86-13A	4	28.5	23.5	28.5	5	12/16/86	112712.34	1090490.94	26.39	26.7 <sup>+</sup>
W92-16A	4	34	24	34	10	6/23/92	112438.05	1091446.66	25.62	25.98
W92-16B	4	45	35	45	10	6/23/92	112424.30	1091445.85	25.51	25.87

**Monitoring Well Construction Information  
Frontier Hard Chrome, Vancouver, Washington**

<b>Well No.</b>	<b>Well Dia. (in)</b>	<b>Well Depth (feet)</b>	<b>Top of Screen Depth (ft)</b>	<b>Bottom of Screen Depth (ft)</b>	<b>Screen Length (ft)</b>	<b>Date Installed</b>	<b>Northing</b>	<b>Easting</b>	<b>Casing Elev. (feet)*</b>	<b>Top of Monument Elev. (feet)*</b>
W97-18A	2	27.5	22.5	27.5	5	2/27/97	112299.62	1091919.98	25.44	25.72
W97-18B	2	44.5	39.5	44.5	5	2/26/97	112299.13	1091926.64	25.36	25.73
W97-19A <sup>#</sup>	2	25	20	25	5	3/17/97	111767.46	1090360.19	22.45**	22.99**
W97-19B <sup>#</sup>	2	45	40	45	5	3/17/97	111758.69	1090357.80	21.72**	22.56**
W98-20A <sup>#</sup>	2	27	22	27	5	5/29/98	111631.28	1090944.00	23.57**	23.87**
W98-21A <sup>#</sup>	2	26	21	26	5	5/27/98	111623.54	1091536.07	25.28**	25.5**
W98-21B <sup>#</sup>	2	44	39	44	5	5/28/98	111616.84	1091543.41	25.5**	25.77**
W99-R5A	2	32.2	22	32	10	1999	110927.24	1089741.49	32.26	NA
W99-R5B	2	49	44	49	5	1999	110929.99	1089743.59	32.33	NA

Notes:

\* Feet above mean sea level. Vertical datum - City of Vancouver benchmark number 108.

\*\* Corrected to common datum. See Section 2.1.3 for explanation.

+ Ground surface elevation.

# Northings and eastings obtained from conversion from GPS latitude and longitude taken February 2, 2004; GPS measurements and conversion done by EPA

Project Name: Frontier Hard Chrome - Event 23

Log Date: 9/12/16

Project Location: 113 Y St., Vancouver, WA 98661

Measurement Method: Water Level Indicator

Project No.: 15272.001.002.0020

Logged By: Brian P. Reilly - WESTON

Well No.	Log Time	Depth to Water (ft)*	Depth to Product (ft)*	Comments
W85-6A	15:50	22.12		Dry wellhead; poor seal; PVC cap
W85-6B	16:00	22.08		Minor H <sub>2</sub> O in WH; good seal; no lock
W85-7A	16:07	22.48		Clay in WH; poor seal; no lock
W85-7B	16:08	22.67		Dry WH; poor seal; no lock; 4"
W88-2D	16:14	22.69		H <sub>2</sub> O filled WH; mod seal
W98-21B	16:24	23.28		Dry WH; mod. seal; no lock
W98-21A	16:22	23.09		Some H <sub>2</sub> O; mod seal; no lock
W85-3B	15:23	22.94		Dry WH; PVC cap; mod seal; 4"
W85-3A				> Could not locate
W85-3	15:33	21.07		Dry WH; mod. seal; PVC cap; (not buried)
W92-16B	15:37	21.74		Dry WH; poor seal; 2 locks; 4"
W92-16A	15:38	21.85		Dry WH; poor seal; no lock; 4"
B87-8	15:42	21.95		Filled w/ seal & H <sub>2</sub> O; mod seal; PVC cap 4"
R85-4	15:49	21.30		Dry WH; mod seal;
W97-18A	15:52	20.89		Dry WH; good seal; no lock
W97-19A	16:30	18.77		Filled w/ H <sub>2</sub> O; good seal
W97-19B	16:32	18.16		Filled w/ H <sub>2</sub> O; mod seal
W99-R5A	16:40	28.58		Some H <sub>2</sub> O in WH; good seal
W99-R5B	16:41	28.64		Filled w/ H <sub>2</sub> O in WH; good seal

\*Measurement Reference Point from ☐ Top of Ground or ☒ Top of Casing



# Groundwater Sampling Record

Project Name: Frontier Hard Chrome - Event 23 Well ID: W85-6B  
Project Location: 113 Y St., Vancouver, WA 98661 Sample No.: 11609048-01  
Project Number: 15272.001.002.0020 Sampler(s): Brian P. Reilly - WESTON  
Date/Time: 9/13/16 0900 Weather: clear, sunny, 64°F

## Water Level Measurements and Purge Data

Time	Depth of Well (TOC)	Depth to Water (TOC)	Feet of Water in Well	Gallons per Well Volume (2" dia. = 0.163 gal/ft, 4" dia. = 0.653 gal/ft)
<u>0925</u>	<u>49.00</u>	<u>22.00</u>	<u>27.00</u>	<u>4.401</u>
	<input type="checkbox"/> Meas. <input checked="" type="checkbox"/> Hist.	Initial		

Water Level Measurement Method: ☒ Electric Tape ☐ Other:

Well Evacuation Method: ☒ Peristaltic Pump ☐ Submersible Pump ☐ Bailer ☐ Other:

Purge Rate: ~250 mL/min

Begin Purge: Time: 0940 Total Volume Purged: ~2 gal.

End Purge: Time: 1040 1045 Well Volumes Purged:

Purge Water Disposed: ☐ 55-gal Drum ☐ Storage Tank ☐ Ground ☐ Liquibin ☒ Other:  
5-gallon Plastic Buckets to be disposed at City of Vancouver's City Operation Center

## Sample Collection Method & Analysis

Sample Type: ☒ Groundwater ☐ Surface Water ☐ Other:

Sample Time: 1045 1050

Sample Collection Method: ☒ Pump Type: Peristaltic Dedicated ☒ Y ☐ N ☐ Bailer ☐ Other:

Decon Procedure: ☒ N/A ☐ Alconox Wash ☐ Tap Rinse ☐ DI Water ☐ Other:

Sample Description (color, turbidity, odor, sheen, etc.): clear, no odor, no sheen

## Sample Containers

Quantity	Size	Bottle Type	Laboratory Analysis
<u>10</u>	<u>500 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>T. Chromium</u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	

## Notes:

① H<sub>2</sub>O<sub>3</sub>

- pump from 24' bgs

Sampler Signature: [Signature]



Date: 9/13/16Well ID: W85-6B**Well Evacuation / Field Parameters**

Time	Depth to Water (TOC)	Volume (gallons)	Temp (°C)	Cond (µS/cm)	DO (mg/L)	pH	ORP (mV)	Color/Turbidity
0940	22.00	0	15.69	306	14.51	8.10	-22.6	1.31
0945	22.00		16.23	306	12.02	7.60	-29.5	1.06
0950	22.00		16.05	306	9.91	7.47	-24.5	2.29
0955	22.00		16.19	305	9.20	7.40	-25.4	1.17
1000	22.00		16.15	306	9.12	7.36	-43.7	1.12
1005	22.00		16.42	305	9.08	7.28	-35.6	1.00
1010	22.00		16.51	305	8.89	7.28	-45.2	0.93
1015	22.00		16.49	305	7.86	7.27	-47.6	1.19
1020	22.00		16.56	304	7.83	7.23	-44.7	0.87
1025	22.00		16.46	303	7.96	7.21	-44.4	0.97
1030	22.00		16.51	303	7.80	7.22	-43.9	1.05
1035	22.00		16.49	302	7.78	7.25	-45.8	1.21
1040	22.00		16.42	302	7.77	7.27	-47.3	1.18
1045	22.00		16.54	301	7.74	7.24	-45.6	0.98

Notes :



# Groundwater Sampling Record

Project Name: Frontier Hard Chrome - Event 23 Well ID: W85-6A  
Project Location: 113 Y St., Vancouver, WA 98661 Sample No.: 1609048-02 / -03 (QA-1)  
Project Number: 15272.001.002.0020 Sampler(s): Brian P. Reilly - WESTON  
Date/Time: 9/13/16 1100 Weather: clear, ~65°F

## Water Level Measurements and Purge Data

Time	Depth of Well (TOC)	Depth to Water (TOC)	Feet of Water in Well	Gallons per Well Volume (2" dia. = 0.163 gal/ft, 4" dia. = 0.653 gal/ft)
<u>1100</u>	<u>27.60</u> <input type="checkbox"/> Meas. <input checked="" type="checkbox"/> Hist.	<u>22.05</u> Initial	<u>4.95</u>	<u>0.81</u>

Water Level Measurement Method: ☒ Electric Tape ☐ Other:

Well Evacuation Method: ☒ Peristaltic Pump ☐ Submersible Pump ☐ Bailer ☐ Other:

Purge Rate: ~250 mL/min

Begin Purge: Time: 1105

Total Volume Purged: ~2.5 gal.

End Purge: Time: 1155

Well Volumes Purged:

Purge Water Disposed: ☐ 55-gal Drum ☐ Storage Tank ☐ Ground ☐ Liquibin ☒ Other:  
5-gallon Plastic Buckets to be disposed at City of Vancouver's City Operation Center

## Sample Collection Method & Analysis

Sample Type: ☒ Groundwater ☐ Surface Water ☐ Other:

Sample Time: 1200

Sample Collection Method: ☒ Pump Type: Peristaltic Dedicated ☒ Y ☐ N ☐ Bailer ☐ Other:

Decon Procedure: ☒ N/A ☐ Alconox Wash ☐ Tap Rinse ☐ DI Water ☐ Other:

Sample Description (color, turbidity, odor, sheen, etc.): clear; no odor; no sheen

## Sample Containers

Quantity	Size	Bottle Type	Laboratory Analysis
<u>10</u>	<u>500 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>T. Chromium</u>
<u>10</u>	<u>500 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>D. Sulfate</u>
<u>1</u>	<u>500 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>Sulfate</u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	<u>(QA-1) - Time = 1205</u>
<u>1</u>	<u>500 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>Sulfate</u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	

## Notes:

- ① H<sub>2</sub>O<sub>2</sub>
- ② filtered

pump from 24' bgs

Sampler Signature: [Signature]

Date: 9/13/16Well ID: W85-6A**Well Evacuation / Field Parameters**

Time	Depth to Water (TOC)	Volume (gallons)	Temp (°C)	Cond (µS/cm)	DO (mg/L)	pH	ORP (mV)	Color/Turbidity
<u>1105</u>	<u>22.05</u>	<u>φ</u>	<u>15.88</u>	<u>326</u>	<u>4.33</u>	<u>6.57</u>	<u>-59.1</u>	<u>0.94</u>
<u>1110</u>	<u>22.05</u>		<u>15.71</u>	<u>326</u>	<u>1.81</u>	<u>6.21</u>	<u>-70.2</u>	<u>1.06</u>
<u>1115</u>	<u>22.05</u>		<u>16.07</u>	<u>326</u>	<u>1.44</u>	<u>6.13</u>	<u>-60.0</u>	<u>1.18</u>
<u>1120</u>	<u>22.05</u>		<u>15.88</u>	<u>326</u>	<u>1.53</u>	<u>6.11</u>	<u>-61.0</u>	<u>1.09</u>
<u>1125</u>	<u>22.05</u>		<u>16.12</u>	<u>325</u>	<u>1.42</u>	<u>6.08</u>	<u>-56.2</u>	<u>1.13</u>
<u>1130</u>	<u>22.05</u>		<u>16.19</u>	<u>326</u>	<u>1.44</u>	<u>6.07</u>	<u>-57.1</u>	<u>1.11</u>
<u>1135</u>	<u>22.05</u>		<u>16.13</u>	<u>326</u>	<u>1.31</u>	<u>6.05</u>	<u>-55.3</u>	<u>1.09</u>
<u>1140</u>	<u>22.05</u>		<u>16.12</u>	<u>326</u>	<u>1.31</u>	<u>6.03</u>	<u>-48.8</u>	<u>1.15</u>
<u>1145</u>	<u>22.05</u>		<u>16.04</u>	<u>325</u>	<u>1.25</u>	<u>6.00</u>	<u>-49.1</u>	<u>1.04</u>
<u>1150</u>	<u>22.05</u>		<u>15.85</u>	<u>325</u>	<u>1.23</u>	<u>5.97</u>	<u>-53.6</u>	<u>1.08</u>
<u>1155</u>	<u>22.05</u>		<u>15.94</u>	<u>324</u>	<u>1.22</u>	<u>5.93</u>	<u>-57.3</u>	<u>0.90</u>

Notes :



# Groundwater Sampling Record

Project Name: Frontier Hard Chrome - Event 23 Well ID: W99-RSA  
Project Location: 113 Y St., Vancouver, WA 98661 Sample No.: 160904B-04  
Project Number: 15272.001.002.0020 Sampler(s): Brian P. Reilly - WESTON  
Date/Time: 9/13/16 1300 Weather: clear; ~75°F

## Water Level Measurements and Purge Data

Time	Depth of Well (TOC)	Depth to Water (TOC)	Feet of Water in Well	Gallons per Well Volume (2" dia. = 0.163 gal/ft, 4" dia. = 0.653 gal/ft)
<u>1325</u>	<u>32.2</u> <input type="checkbox"/> Meas. <input checked="" type="checkbox"/> Hist.	<u>28.58</u> Initial	<u>3.62</u>	<u>0.59</u>

Water Level Measurement Method: ☒ Electric Tape ☐ Other:

Well Evacuation Method: ☒ Peristaltic Pump ☐ Submersible Pump ☐ Bailer ☐ Other:

Purge Rate: N/A (see notes)

Begin Purge: Time:                      Total Volume Purged:                     

End Purge: Time:                      Well Volumes Purged:                     

Purge Water Disposed: ☐ 55-gal Drum ☐ Storage Tank ☐ Ground ☐ Liquibin ☒ Other:  
5-gallon Plastic Buckets to be disposed at City of Vancouver's City Operation Center

## Sample Collection Method & Analysis

Sample Type: ☒ Groundwater ☐ Surface Water ☐ Other:

Sample Time: 1445

Sample Collection Method: ☒ Pump Type: Peristaltic Dedicated ☒ Y ☐ N ☐ Bailer ☐ Other:

Decon Procedure: ☒ N/A ☐ Alconox Wash ☐ Tap Rinse ☐ DI Water ☐ Other:

Sample Description (color, turbidity, odor, sheen, etc.): clear; no odor; no sheen

## Sample Containers

Quantity	Size	Bottle Type	Laboratory Analysis
<u>10</u>	<u>500 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>T. Chromium</u>
<u>100</u>	<u>500 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>D. Sulfur</u>
<u>1</u>	<u>500 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>Sulfate</u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	

## Notes:

① 1003  
② filtered

- pump from 29'

Sampler Signature: [Signature]







# Groundwater Sampling Record

Project Name: Frontier Hard Chrome - Event 23 Well ID: W99-R5B  
Project Location: 113 Y St., Vancouver, WA 98661 Sample No.: 1609048-05  
Project Number: 15272.001.002.0020 Sampler(s): Brian P. Reilly - WESTON  
Date/Time: 9/13/16 1400 Weather: clear; ~80°F

## Water Level Measurements and Purge Data

Time	Depth of Well (TOC)	Depth to Water (TOC)	Feet of Water in Well	Gallons per Well Volume (2" dia. = 0.163 gal/ft, 4" dia. = 0.653 gal/ft)
<u>1400</u>	<u>44.0</u>	<u>28.66</u>	<u>15.34</u>	<u>2.50</u>
	<input type="checkbox"/> Meas. <input checked="" type="checkbox"/> Hist.	<u>Initial</u>		

Water Level Measurement Method: ☒ Electric Tape ☐ Other:

Well Evacuation Method: ☒ Peristaltic Pump ☐ Submersible Pump ☐ Bailer ☐ Other:

Purge Rate: (2) N/A (see notes)

Begin Purge: Time:                      Total Volume Purged: 0

End Purge: Time:                      Well Volumes Purged:                     

Purge Water Disposed: ☐ 55-gal Drum ☐ Storage Tank ☐ Ground ☐ Liquibin ☒ Other:  
5-gallon Plastic Buckets to be disposed at City of Vancouver's City Operation Center

## Sample Collection Method & Analysis

Sample Type: ☒ Groundwater ☐ Surface Water ☐ Other:

Sample Time: 1430

Sample Collection Method: ☒ Pump Type: Peristaltic Dedicated ☒ Y ☐ N ☐ Bailer ☐ Other:

Decon Procedure: ☒ N/A ☐ Alconox Wash ☐ Tap Rinse ☐ DI Water ☐ Other:

Sample Description (color, turbidity, odor, sheen, etc.): clear; no odor; no sheen

## Sample Containers

Quantity	Size	Bottle Type	Laboratory Analysis
<u>1<sup>①</sup></u>	<u>500mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>T. Chromium</u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	

## Notes:

- ① HVO<sub>2</sub>
- ② see note ① on reverse

-pump from 29' dgs

Sampler Signature: [Signature]





# Groundwater Sampling Record

Project Name: Frontier Hard Chrome - Event 23 Well ID: BBS-4  
Project Location: 113 Y St., Vancouver, WA 98661 Sample No.: 1609048-06  
Project Number: 15272.001.002.0020 Sampler(s): Brian P. Reilly - WESTON  
Date/Time: 9/13/16 15:30 Weather: clear; sunny; ~82°F

## Water Level Measurements and Purge Data

Time	Depth of Well (TOC)	Depth to Water (TOC)	Feet of Water in Well	Gallons per Well Volume (2" dia. = 0.163 gal/ft, 4" dia. = 0.653 gal/ft)
<u>15:40</u>	<u>26.5</u> <input type="checkbox"/> Meas. <input checked="" type="checkbox"/> Hist.	<u>21.25</u> Initial	<u>5.25</u>	<u>0.86</u>

Water Level Measurement Method: ☒ Electric Tape ☐ Other:

Well Evacuation Method: ☒ Peristaltic Pump ☐ Submersible Pump ☐ Bailer ☐ Other:

Purge Rate: ~250 mL/min

Begin Purge: Time: 1545

Total Volume Purged: ~3 gal.

End Purge: Time: 1650

Well Volumes Purged:

Purge Water Disposed: ☐ 55-gal Drum ☐ Storage Tank ☐ Ground ☐ Liquibin ☒ Other:  
5-gallon Plastic Buckets to be disposed at City of Vancouver's City Operation Center

## Sample Collection Method & Analysis

Sample Type: ☒ Groundwater ☐ Surface Water ☐ Other:

Sample Time: 1655

Sample Collection Method: ☒ Pump Type: Peristaltic Dedicated ☒ Y ☐ N ☐ Bailer ☐ Other:

Decon Procedure: ☒ N/A ☐ Alconox Wash ☐ Tap Rinse ☐ DI Water ☐ Other:

Sample Description (color, turbidity, odor, sheen, etc.): clear; no odor; no sheen

## Sample Containers

Quantity	Size	Bottle Type	Laboratory Analysis
<u>1<sup>①</sup></u>	<u>500</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>T. Chromium</u>
<u>1<sup>②</sup></u>	<u>500</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>D. Sulfur</u>
<u>1</u>	<u>500</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>Sulfate</u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	<u><del>DA-27</del> time =</u>
<u>1</u>	<u>500</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u><del>T. Chromium</del></u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	<u>→ Replaced w/ dup @ W97-19A</u>

## Notes:

- ① H<sub>2</sub>O<sub>2</sub>
- ② filtered

camp from 24' bgs

Sampler Signature: [Signature]



Date: 9/13/16Well ID: B85-4**Well Evacuation / Field Parameters**

Time	Depth to Water (TOC)	Volume (gallons)	Temp (°C)	Cond (µS/cm)	DO (mg/L)	pH	ORP (mV)	Color/Turbidity
1545	21.25	Ø	16.52	553	2.83	6.11	-80.3	1.65
1550	21.25		16.19	562	0.97	5.83	-29.9	1.41
1555	21.25		16.31	562	0.56	5.79	-14.8	1.44
1600	21.25		16.28	562	0.56	5.81	-9.2	1.39
1605	21.25		16.14	563	0.57	5.80	-20.7	1.24
1610	21.25		16.09	563	0.54	5.85	-23.2	1.18
1615	21.25		16.02	564	0.50	5.83	-27.4	1.11
1620	21.25		16.04	565	0.46	5.72	-13.8	1.28
1625	21.25		16.09	566	0.39	5.61	-1.8	1.50
1630	21.25		15.93	567	0.41	5.54	14.8	1.36
1635	21.25		16.08	566	0.38	5.29	29.3	1.12
1640	21.25		16.32	566	0.34	5.16	61.2	1.00
1645	21.25		16.34	567	0.38	5.08	74.5	1.14
1650	21.25		16.36	568	0.36	4.96	88.3	1.22

Notes :



# Groundwater Sampling Record

Project Name: Frontier Hard Chrome - Event 23 Well ID: W98-21B  
Project Location: 113 Y St., Vancouver, WA 98661 Sample No.: 1609048-08-07  
Project Number: 15272.001.002.0020 Sampler(s): Brian P. Reilly - WESTON  
Date/Time: 9/14/16 0830 Weather: clear; ~ 60°F

## Water Level Measurements and Purge Data

Time	Depth of Well (TOC)	Depth to Water (TOC)	Feet of Water in Well	Gallons per Well Volume (2" dia. = 0.163 gal/ft, 4" dia. = 0.653 gal/ft)
<u>0845</u>	<u>44.0</u>	<u>23.28<sup>3</sup></u>	<u>20.72</u>	<u>3.38</u>
	<input type="checkbox"/> Meas. <input checked="" type="checkbox"/> Hist.	Initial		

Water Level Measurement Method: ☒ Electric Tape ☐ Other:

Well Evacuation Method: ☒ Peristaltic Pump ☐ Submersible Pump ☐ Bailer ☐ Other:

Purge Rate: ~ 200 mL/min

Begin Purge: Time: 0900

Total Volume Purged: ~ 2.5 gal

End Purge: Time: 0945

Well Volumes Purged:

Purge Water Disposed: ☐ 55-gal Drum ☐ Storage Tank ☐ Ground ☐ Liquibin ☒ Other:  
5-gallon Plastic Buckets to be disposed at City of Vancouver's City Operation Center

## Sample Collection Method & Analysis

Sample Type: ☒ Groundwater ☐ Surface Water ☐ Other:

Sample Time: 0950

Sample Collection Method: ☒ Pump Type: Peristaltic Dedicated ☒ Y ☐ N ☐ Bailer ☐ Other:

Decon Procedure: ☒ N/A ☐ Alconox Wash ☐ Tap Rinse ☐ DI Water ☐ Other:

Sample Description (color, turbidity, odor, sheen, etc.): clear, no odor, no sheen

## Sample Containers

Quantity	Size	Bottle Type	Laboratory Analysis
<u>10</u>	<u>500mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>T. Chromium</u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	

## Notes:

① HNO<sub>3</sub>  
③ - see note '1' on back

- pump from 25' bgs

Sampler Signature: [Signature]





# Groundwater Sampling Record

Project Name: Frontier Hard Chrome - Event 23 Well ID: W98-21A  
Project Location: 113 Y St., Vancouver, WA 98661 Sample No.: 1609048-04-08  
Project Number: 15272.001.002.0020 Sampler(s): Brian P. Reilly - WESTON  
Date/Time: 9/14/16 0950 Weather: clear; ~70°F

## Water Level Measurements and Purge Data

Time	Depth of Well (TOC)	Depth to Water (TOC)	Feet of Water in Well	Gallons per Well Volume (2" dia. = 0.163 gal/ft, 4" dia. = 0.653 gal/ft)
<u>0950</u>	<u>26.0</u> <input type="checkbox"/> Meas. <input checked="" type="checkbox"/> Hist.	<u>23.02</u> Initial	<u>2.98</u>	<u>0.49</u>

Water Level Measurement Method: ☒ Electric Tape ☐ Other:

Well Evacuation Method: ☒ Peristaltic Pump ☐ Submersible Pump ☐ Bailer ☐ Other:

Purge Rate: ~200 mL/min

Begin Purge: Time: 0950 0955

Total Volume Purged: ~2.5 gal

End Purge: Time: 1045

Well Volumes Purged:

Purge Water Disposed: ☐ 55-gal Drum ☐ Storage Tank ☐ Ground ☐ Liquibin ☒ Other:  
5-gallon Plastic Buckets to be disposed at City of Vancouver's City Operation Center

## Sample Collection Method & Analysis

Sample Type: ☒ Groundwater ☐ Surface Water ☐ Other:

Sample Time: 1050

Sample Collection Method: ☒ Pump Type: Peristaltic Dedicated ☒ Y ☐ N ☐ Bailer ☐ Other:

Decon Procedure: ☒ N/A ☐ Alconox Wash ☐ Tap Rinse ☐ DI Water ☐ Other:

Sample Description (color, turbidity, odor, sheen, etc.): clear; no odor; no sheen

## Sample Containers

Quantity	Size	Bottle Type	Laboratory Analysis
<u>10</u>	<u>500 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>T. Chromium</u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	

## Notes:

① H2O3

→ pump from 25' bgs

Sampler Signature: [Signature]

Date: 9/14/16Well ID: W98-21A**Well Evacuation / Field Parameters**

Time	Depth to Water (TOC)	Volume (gallons)	Temp (°C)	Cond (µS/cm)	DO (mg/L)	pH	ORP (mV)	Color/Turbidity
<del>0950</del> 0955	23.02	0	15.13	300	3.71	6.41	-33.9	0.84
1000	23.02		14.89	304	2.57	6.37	-47.7	0.97
1005	23.02		14.70	310	2.13	6.37	-62.4	0.95
1010	23.02		14.80	314	1.88	6.37	-65.7	1.00
1015	23.02		14.90	314	1.83	6.41	-63.9	0.96
1020	23.02		14.95	314	1.79	6.39	-58.7	1.11
1025	23.02		15.01	314	1.75	6.37	-51.2	1.05
1030	23.02		14.97	314	1.66	6.38	-50.0	0.90
1035	23.02		15.02	314	1.64	6.37	-51.1	0.95
1040	23.02		15.00	314	1.65	6.36	-51.1	0.84
1045	23.02		15.01	314	1.66	6.36	-51.0	0.72

Notes :





# Groundwater Sampling Record

Project Name: Frontier Hard Chrome - Event 23 Well ID: W97-18A  
Project Location: 113 Y St., Vancouver, WA 98661 Sample No.: 1609048-09  
Project Number: 15272.001.002.0020 Sampler(s): Brian P. Reilly - WESTON  
Date/Time: 9/14/16 1135 Weather: clear; ~80°F

## Water Level Measurements and Purge Data

Time	Depth of Well (TOC)	Depth to Water (TOC)	Feet of Water in Well	Gallons per Well Volume (2" dia. = 0.163 gal/ft, 4" dia. = 0.653 gal/ft)
<u>1140</u>	<u>27.5</u> <input type="checkbox"/> Meas. <input checked="" type="checkbox"/> Hist.	<u>20.84</u> Initial	<u>10.66</u>	<u>1.09</u>

Water Level Measurement Method: ☒ Electric Tape ☐ Other:

Well Evacuation Method: ☒ Peristaltic Pump ☐ Submersible Pump ☐ Bailer ☐ Other:

Purge Rate: ~200 mL/min

Begin Purge: Time: 1145 Total Volume Purged: ~2.5 gal

End Purge: Time: 1245 Well Volumes Purged:

Purge Water Disposed: ☐ 55-gal Drum ☐ Storage Tank ☐ Ground ☐ Liquibin ☒ Other:  
5-gallon Plastic Buckets to be disposed at City of Vancouver's City Operation Center

## Sample Collection Method & Analysis

Sample Type: ☒ Groundwater ☐ Surface Water ☐ Other:

Sample Time: 1250

Sample Collection Method: ☒ Pump Type: Peristaltic Dedicated: ☒ Y ☐ N ☐ Bailer ☐ Other:

Decon Procedure: ☒ N/A ☐ Alconox Wash ☐ Tap Rinse ☐ DI Water ☐ Other:

Sample Description (color, turbidity, odor, sheen, etc.): clear; no odor; no sheen

## Sample Containers

Quantity	Size	Bottle Type	Laboratory Analysis
<u>1<sup>0</sup></u>	<u>500mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>T. Chromium</u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	

## Notes:

CHNO<sub>3</sub>

- pump from 24' bgs

Sampler Signature: [Signature]

Date: 9/14/16Well ID: W97-18A**Well Evacuation / Field Parameters**

Time	Depth to Water (TOC)	Volume (gallons)	Temp (°C)	Cond (µS/cm)	DO (mg/L)	pH	ORP (mV)	Color/Turbidity
1145	20.84	∅	15.67	206	3.87	6.80	-93.4	1.55
1150	20.80		15.02	206	2.18	6.34	-80.9	1.50
1155	20.80		16.05	206	1.79	6.18	-81.7	0.99
1200	20.80		15.55	209	1.43	6.07	-80.6	0.78
1205	20.80		15.10	212	1.02	5.97	-79.4	0.55
1210	20.80		15.16	212	0.95	5.94	-55.7	0.81
1215	20.80		15.65	213	0.83	5.95	-59.3	0.89
1220	20.80		16.08	213	0.70	5.94	-68.1	1.03
1225	20.80		16.62	215	0.59	6.00	-84.2	1.01
1230	20.80		16.61	215	0.58	5.98	-80.3	1.12
1235	20.80		16.62	214	0.56	5.99	-74.6	1.04
1240	20.80	1	16.62	215	0.54	5.98	-62.4	0.91
1245	20.80		15.99	216	0.47	5.96	-80.6	1.05

Notes :



# Groundwater Sampling Record

Project Name: Frontier Hard Chrome - Event 23 Well ID: W97-19A  
Project Location: 113 Y St., Vancouver, WA 98661 Sample No.: 1609048-10/-11 (QA-2)  
Project Number: 15272.001.002.0020 Sampler(s): Brian P. Reilly - WESTON  
Date/Time: 9/14/16 1400 Weather: clear; ~80°F

## Water Level Measurements and Purge Data

Time	Depth of Well (TOC)	Depth to Water (TOC)	Feet of Water in Well	Gallons per Well Volume (2" dia. = 0.163 gal/ft, 4" dia. = 0.653 gal/ft)
<u>1420</u>	<u>25.00</u> <input type="checkbox"/> Meas. <input checked="" type="checkbox"/> Hist.	<u>18.74</u> Initial	<u>6.26</u>	<u>1.02</u>

Water Level Measurement Method: ☒ Electric Tape ☐ Other:

Well Evacuation Method: ☒ Peristaltic Pump ☐ Submersible Pump ☐ Bailer ☐ Other:

Purge Rate: ~250 mL/min

Begin Purge: Time: 1425 Total Volume Purged: ~2.5 gal.

End Purge: Time: 1520 Well Volumes Purged:

Purge Water Disposed: ☐ 55-gal Drum ☐ Storage Tank ☐ Ground ☐ Liquibin ☒ Other:  
5-gallon Plastic Buckets to be disposed at City of Vancouver's City Operation Center

## Sample Collection Method & Analysis

Sample Type: ☒ Groundwater ☐ Surface Water ☐ Other:

Sample Time: 1525

Sample Collection Method: ☒ Pump Type: Peristaltic Dedicated ☒ Y ☐ N ☐ Bailer ☐ Other:

Decon Procedure: ☒ N/A ☐ Alconox Wash ☐ Tap Rinse ☐ DI Water ☐ Other:

Sample Description (color, turbidity, odor, sheen, etc.): clear; no odor; no sheen

## Sample Containers

Quantity	Size	Bottle Type	Laboratory Analysis
<u>10</u>	<u>800 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>T. Chromium</u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
<u>10</u>	<u>500 mL</u>	<input type="checkbox"/> Glass <input type="checkbox"/> Poly	<u>[QA-2] time = 1530</u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	<u>T. Chromium</u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	

## Notes:

09/14/16  
-confirmed this is the northern well  
by measuring well casing depth (approx.)

Sampler Signature: [Signature]

-pump from 22' bgs

18.74



Date: 9/14/16Well ID: W97-19A**Well Evacuation / Field Parameters**

Time	Depth to Water (TOC)	Volume (gallons)	Temp (°C)	Cond (µS/cm)	DO (mg/L)	pH	ORP (mV)	Color/Turbidity
1425	18.74	Ø	17.00	299	6.01	6.67	-78.6	11.69 <sup>①</sup>
1430	18.74		16.20	299	3.63	5.80	-30.8	7.55
1435	18.74		16.70	300	3.34	5.64	-23.2	6.15
1440	18.74		16.55	301	3.02	5.53	-23.6	3.54
1445	18.74		16.62	302	2.88	5.65	-24.7	3.54
1450	18.74		17.15	301	2.89	5.71	-26.9	2.28
1455	18.74		16.89	302	2.85	5.63	-21.3	2.34
1500	18.74		16.29	303	2.83	5.56	-17.8	2.57
1505	18.74		16.18	303	2.82	5.55	-16.2	2.61
1510	18.74		16.43	303	2.83	5.55	-15.9	2.53
1515	18.74		16.46	303	2.81	5.61	-19.7	2.31
1520	18.74		16.32	303	2.80	5.62	-21.5	2.14

**Notes :**

① - Turbidity likely high due to sediment stirred up by sounding to total well depth



# Groundwater Sampling Record

Project Name: Frontier Hard Chrome - Event 23 Well ID: W97-19B  
Project Location: 113 Y St., Vancouver, WA 98661 Sample No.: 1609048-12  
Project Number: 15272.001.002.0020 Sampler(s): Brian P. Reilly - WESTON  
Date/Time: 9/14/16 1525 Weather: clear; ~85°F

## Water Level Measurements and Purge Data

Time	Depth of Well (TOC)	Depth to Water (TOC)	Feet of Water in Well	Gallons per Well Volume (2" dia. = 0.163 gal/ft, 4" dia. = 0.653 gal/ft)
<u>1525</u>	<u>45.00</u>	<u>18.10</u>	<u>26.9</u>	<u>4.38</u>
<input type="checkbox"/> Meas.	<input checked="" type="checkbox"/> Hist.	Initial		

Water Level Measurement Method: ☒ Electric Tape ☐ Other:

Well Evacuation Method: ☒ Peristaltic Pump ☐ Submersible Pump ☐ Bailer ☐ Other:

Purge Rate: ~250 mL/min

Begin Purge: Time: 1530

Total Volume Purged: ~2.5 gal

End Purge: Time: 1620

Well Volumes Purged:

Purge Water Disposed: ☐ 55-gal Drum ☐ Storage Tank ☐ Ground ☐ Liquibin ☒ Other:  
5-gallon Plastic Buckets to be disposed at City of Vancouver's City Operation Center

## Sample Collection Method & Analysis

Sample Type: ☒ Groundwater ☐ Surface Water ☐ Other:

Sample Time: 1625

Sample Collection Method: ☒ Pump Type: Peristaltic Dedicated ☒ Y ☐ N ☐ Bailer ☐ Other:

Decon Procedure: ☒ N/A ☐ Alconox Wash ☐ Tap Rinse ☐ DI Water ☐ Other:

Sample Description (color, turbidity, odor, sheen, etc.): slightly yellow; no odor; no sheen

## Sample Containers

Quantity	Size	Bottle Type	Laboratory Analysis
<u>10</u>	<u>500 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>T. Chromium</u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	

## Notes:

① HNO<sub>3</sub>

pump from 22' Lgs

Sampler Signature: [Signature]

Date: 9/14/16Well ID: W97-19B**Well Evacuation / Field Parameters**

Time	Depth to Water (TOC)	Volume (gallons)	Temp (°C)	Cond (µS/cm)	DO (mg/L)	pH	ORP (mV)	Color/Turbidity
1530	18.10	0	15.82	256	3.25	5.37	9.3	3.45
1535	18.15		15.76	248	2.42	5.86	10.5	1.93
1540	18.15		15.62	245	1.97	5.49	-3.4	1.51
1545	18.15		15.52	243	1.69	5.38	4.9	1.58
1550	18.15		15.17	240	1.40	5.55	-9.9	1.42
1555	18.15		15.00	239	1.31	5.71	-18.7	1.61
1600	18.15		14.98	239	1.28	5.89	-36.4	1.53
① 1605	18.15		16.17	240	1.17	6.12	-58.4	1.86
1610	18.15		14.94	241	0.90	6.11	-65.4	2.54
1615	18.15		14.97	241	0.83	6.13	-51.6	3.85
1620	18.15		14.95	242	0.80	6.17	-46.3	3.85

**Notes :**

① YSI tubing came out and emptied chamber



# Groundwater Sampling Record

Project Name: Frontier Hard Chrome - Event 23 Well ID: B87-8  
Project Location: 113 Y St., Vancouver, WA 98661 Sample No.: 1609048-13 / -14 (QA-3)  
Project Number: 15272.001.002.0020 Sampler(s): Brian P. Reilly - WESTON  
Date/Time: 9/15/16 1030 Weather: clear; ~65°F

## Water Level Measurements and Purge Data

Time	Depth of Well (TOC)	Depth to Water (TOC)	Feet of Water in Well	Gallons per Well Volume (2" dia. = 0.163 gal/ft, 4" dia. = 0.653 gal/ft)
<u>1040</u>	<u>29.5</u> <input type="checkbox"/> Meas. <input checked="" type="checkbox"/> Hist.	<u>21.87</u> Initial	<u>7.63</u>	<u>4.98</u>

Water Level Measurement Method: ☒ Electric Tape ☐ Other:

Well Evacuation Method: ☒ Peristaltic Pump ☐ Submersible Pump ☐ Bailer ☐ Other:

Purge Rate: ~250 mL/min

Begin Purge: Time: 1050

Total Volume Purged: ~3 gal

End Purge: Time: 1210

Well Volumes Purged:

Purge Water Disposed: ☐ 55-gal Drum ☐ Storage Tank ☐ Ground ☐ Liquibin ☒ Other:  
5-gallon Plastic Buckets to be disposed at City of Vancouver's City Operation Center

## Sample Collection Method & Analysis

Sample Type: ☒ Groundwater ☐ Surface Water ☐ Other:

Sample Time: 1220

Sample Collection Method: ☒ Pump Type: Peristaltic Dedicated ☒ Y ☐ N ☐ Bailer ☐ Other:

Decon Procedure: ☒ N/A ☐ Alconox Wash ☐ Tap Rinse ☐ DI Water ☐ Other:

Sample Description (color, turbidity, odor, sheen, etc.): slightly cloudy; no color; no sheen

## Sample Containers

Quantity	Size	Bottle Type	Laboratory Analysis
<u>1</u> <sup>①</sup>	<u>500 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>T. Chromium</u>
<u>1</u> <sup>① ③</sup>	<u>500 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>D. Chromium</u>
<u>1</u> <sup>② ③</sup>	<u>250 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>D. Hexachrome</u>
<u>1</u>	<u>500 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>Sulfate</u>
<u>1</u> <sup>① ③</sup>	<u>500 mL</u>	<input type="checkbox"/> Glass <input checked="" type="checkbox"/> Poly	<u>D. Sulfur</u>
		<input type="checkbox"/> Glass <input type="checkbox"/> Poly	

## Notes:

① H<sub>2</sub>O<sub>2</sub>  
② buffer solution (pH → 9-9.5)  
③ filtered  
- pump from 25' bgs

Ferrus Iron = 0.25 mg/L  
( $< 0.5$ )

DO =  $\emptyset$  ( $< 0.2$ )

[QA-3] time = 1230  
(same containers/pres.)

T. Chromium  
D. Chromium  
D. Hexachrome

Sampler Signature: [Signature]



Date: 9/15/16Well ID: B07-8**Well Evacuation / Field Parameters**

Time	Depth to Water (TOC)	Volume (gallons)	Temp (°C)	Cond (µS/cm)	DO (mg/L)	pH	ORP (mV)	Color/Turbidity
<u>1050</u>	<u>21.87</u>	<u>✓</u>	<u>15.51</u>	<u>245</u>	<u>3.18</u>	<u>7.14</u>	<u>-95.1</u>	<u>18.56</u>
<u>1055</u>	<u>21.87</u>		<u>15.34</u>	<u>259</u>	<u>1.45</u>	<u>6.62</u>	<u>-82.8</u>	<u>10.52</u>
<u>1100</u>	<u>21.87</u>		<u>15.45</u>	<u>270</u>	<u>1.08</u>	<u>6.57</u>	<u>-81.8</u>	<u>6.62</u>
<u>1105</u>	<u>21.87</u>		<u>15.55</u>	<u>278</u>	<u>0.66</u>	<u>6.58</u>	<u>-92.2</u>	<u>6.34</u>
<u>1110</u>	<u>21.87</u>		<u>14.91</u>	<u>297</u>	<u>1.20</u>	<u>6.60</u>	<u>-66.9</u>	<u>4.35</u>
<u>1115</u>	<u>21.87</u>		<u>15.01</u>	<u>299</u>	<u>0.51</u>	<u>6.62</u>	<u>-90.0</u>	<u>3.49</u>
<u>1120</u>	<u>21.87</u>		<u>15.20</u>	<u>305</u>	<u>0.45</u>	<u>6.64</u>	<u>-97.1</u>	<u>3.85</u>
<u>1125</u>	<u>21.87</u>		<u>15.43</u>	<u>313</u>	<u>0.84</u>	<u>6.65</u>	<u>-72.2</u>	<u>3.98</u>
<u>1130</u>	<u>21.87</u>		<u>15.84</u>	<u>318</u>	<u>1.31</u>	<u>6.67</u>	<u>-88.6</u>	<u>5.79</u>
<u>1135</u>	<u>21.87</u>		<u>15.14</u>	<u>319</u>	<u>1.06</u>	<u>6.66</u>	<u>-99.4</u>	<u>6.08</u>
<u>1140</u>	<u>21.87</u>		<u>14.98</u>	<u>323</u>	<u>0.75</u>	<u>6.66</u>	<u>-104.9</u>	<u>5.68</u>
<u>1145</u>	<u>21.87</u>		<u>15.11</u>	<u>334</u>	<u>0.65</u>	<u>6.68</u>	<u>-88.1</u>	<u>5.11</u>
<u>1150</u>	<u>21.87</u>		<u>15.08</u>	<u>338</u>	<u>0.64</u>	<u>6.69</u>	<u>-103.0</u>	<u>4.48</u>
<u>1155</u>	<u>21.87</u>		<u>14.92</u>	<u>353</u>	<u>0.67</u>	<u>6.70</u>	<u>-113.8</u>	<u>2.40</u>
<u>1200</u>	<u>21.87</u>		<u>14.96</u>	<u>362</u>	<u>0.36</u>	<u>6.72</u>	<u>-122.5</u>	<u>2.83</u>
<u>1205</u>	<u>21.87</u>		<u>15.10</u>	<u>368</u>	<u>0.38</u>	<u>6.73</u>	<u>-110.5</u>	<u>2.79</u>
<u>1210</u>	<u>21.87</u>		<u>15.35</u>	<u>374</u>	<u>0.46</u>	<u>6.74</u>	<u>-103.1</u>	<u>2.75</u>

**Notes :**

① YSI chamber drained and likely skewed readings